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AIR FORCE HUMAN RESOURCES LABORATORY

COMPUTER-MANAGED INSTRUCTION:

DEVELOPMENT AND EVALUATION OF STUDENT SKILL MODULES TO REDUCE TRAINING TIME

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The development and evaluation of the CMI Student Skills Project are described within the context of the Air Force Advanced Instructional System (AIS). The student skill modules developed were designed as short packages to be assigned near the beginning of any military technical training course, but which included strategies or procedures that would continue to effect student behavior throughout the course (e.g., behavioral self control techniques). Following a series of student interviews to determine the characteristic problems students encounter in a CMI system, an Orientation to CMI/Time Management Lesson and Study Skills Package were developed and implemented. The Study Skills Package included a self-rating Student Study Skills Questionnaire and four study skills training modules in the areas of reading comprehension, memorization, test taking, and concentration

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management skills. An Instructor Orientation and Training Package was also developed to be used in conjunction with the study skills diagnostic and remedial materials, and to provide instructors with basic skills in their new role as facilitator of student learning. Evaluation results indicated that (a) substantial time savings can be obtained by a combination of CMI orientation and time management skill training with a computer-based progress targeting and feedback system (i.e., on the order of nine to 18 percent reductions in course completion times); (b) consistent student training time reductions and performance gains can be obtained by the use of the study skills materials for students identified as deficient in particular study skills areas; (c) the Study Skills Questionnaire was a reliable and valid measure of student skills in the four study skills areas and reliably discriminated students performing satisfactorily versus poorly in the AIS technical training environment; and (d) the Instructor Orientation and Training contributed to the efficient remediation of student study skill deficiencies and improved instructor perceptions of their CMI role. The results of this project are separately described in two sections of this report: an Executive Report Section and a Scientific Data Section.

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SUMMARY

OBJECTIVES

The promises of individualized materials and computer-based instructional systems for improving training effectiveness and efficiency have been recognized by the Department of Defense as viable means for reducing military technical training costs. In the military training environment, every day of training time saved by innovations in training materials or procedures can result in considerable savings in training dollars and more efficient utilization of manpower in the field. To date, however, little effort has been devoted to the problem of preparing students to use computer-based or computer-managed instructional (CMI) systems effectively.

The goals of the CMI Student Skills Project were, therefore, to (a) determine the characteristic problems which students encounter in a computer-managed instructional (CMI) system and those strategies which effectively help students cope with these problems, (b) design, develop, implement, and evaluate a small set of self-contained instructional modules for increasing the effectiveness with which students adapt to and perform in a CMI environment, and (c) investigate procedures for individualizing assignment of these modules so as to minimize training time and cost. The project context was the Air Force Advanced Instructional System (AIS), Lowry AFB, Colorado.

APPROACH

The student skills modules developed were designed as short packages to be assigned near the beginning of an arbitrary military technical training course, but which also incorporated strategies or procedures that would continue to affect student behavior throughout the course. In the process of module design and implementation, it became apparent that instructor understanding and appreciation of project goals and objectives, as well as implementation procedures and strategies involved in the skill modules, were critical to the potential success of such skill training. For this reason, an instructor orientation and training package was developed in place of the originally planned computer-based individualization procedures.

METHODS

To determine the characteristic problems which students encounter in a novel CMI environment, students from two AIS courses were interviewed in two phases of the project. Interviews in the first phase focused on student reactions to the CMI environment, features they liked and disliked, problems they had experienced, and information they would have found helpful about the environment. An Orientation to CMI Module and a Time Management Module were designed on the basis of these initial student interviews.

The second phase of student interviews focused on specific student study skills problems in a CMI environment. The results of these interviews, along with information from instructors and supervisors, formed the basis for the design of a Study Skills Package. This package contained a Student Study Skills Questionnaire and separate skill training materials in the areas of Reading Comprehension, Memorization, Test Taking, and Concentration Management skills. Additionally, and Instructor Orientation and Training Workshop was designed to (a) acquaint instructors with the techniques and strategies in the four Study Skills Modules, (b) teach them basic diagnostic and tutorial skills for the individualized assignment of students to the Study Skills Modules, and (c) provide them with a better perception of their CMI instructor role.

All skills modules, the Study Skills Questionnaire, and the instructor package were subjected to formative evaluation, and revisions were made as appropriate. Due to operational constraints, summative evaluations (a second set of large scale tryouts) were completed for only the Time Management Module (using students from the Inventory Management (IM) and Materiel Facilities (MF) courses) and the Study Skills Questionnaire (using students from the IM and Weapons Mechanic (WM) courses).

RESULTS AND CONCLUSIONS

Operational tryout of the Orientation Module was restricted to the Precision Measuring Equipment (PME) course. During the evaluation period, the module was administered to students in the first CMI block of the course in an Orientation/No-Orientation evaluation design. No reliable differences were found between the block times, block scores, or attitudes toward CMI for students in the two groups. These results are tentative due to low student flow and, hence, small sample sizes. The average time spent by students on the module was only 42 minutes, indicating that the time required for such an orientation is not excessive.

The Time Management Module was subjected to an extensive two-phase summative evaluation, during which (a) the module and the AIS Student Progress Management Component (SPMC) were compared with a no-module, no-SPMC condition in Phase I and (b) the module per se was evaluated in the presence of the SPMC, as compared with a no-module, SPMC condition in Phase II. The results of these evaluations revealed time savings of 11.2 and 9.0 percent, respectively, with the overall effectiveness of the module and SPMC conservatively estimated to be in excess of 18.0 percent by the end of the Phase II evaluation. It was concluded that the time spent on the module (approximately 80 minutes) was a cost that was quickly amortized in terms of the savings in technical training time.

The four Study Skills Modules were subjected to an operational tryout in the IM, MF, and WM courses. Although the number of cases for

this evaluation was small (n=11), the findings of dramatic student improvement in block times and scores following the study skills remediation were so consistent as to warrant the conclusion that this training met the goal of increasing student efficiency and effectiveness in a CMI environment.

The Study Skills Questionnaire was subjected to a full summative evaluation in which data on questionnaire reliability and validity were collected in the four AIS courses. The results indicated that the questionnaire and its subscales had good reliability and construct validity. The predictive validity analyses supported the power of this measure to discriminate between students who would perform well versus those who would perform poorly in a CMI environment such as the AIS.

Evaluation data for the Instructor Orientation and Training Workshops were provided by instructor critiques of the workshops and by subsequent instructor use of their new skills in assigning students to particular study skills materials. Results were favorable in both areas and it was concluded, therefore, that the Instructor Orientation and Training was successful in promoting the remediation of student study skills problems--a finding further substantiated by the consistent improvements in student block times and scores following this remediation. In addition, the training appeared to have a positive effect on instructor role perceptions.

RECOMMENDATIONS

The overall results of this project indicate that it is not only feasible but also beneficial, in terms of training efficiency, effectiveness, and cost, to train students in the basic skills required to perform effectively in a CMI environment. On the basis of these results, it is suggested that the present student skills modules at least be implemented in the AIS courses. It is also recommended that the Study Skills Package be given trial implementation in the non-CMI courses where these same basic skills would be important. Implementation should follow procedures discussed in this report, with special emphasis given to the role of the instructor.

PREFACE

The authors wish to express their appreciation to a number of persons whose assistance and cooperation made significant contributions to the work reported here. Dr. Frank C. Richardson, University of Texas at Austin, provided invaluable guidance in the design of the student skill modules, the instructor orientation package, and their accompanying procedures. The previous research and materials developed by Dr. Donald F. Dansereau, Dr. Claire E. Weinstein, and Dr. Katheryn K. Woodley were invaluable in the development of the study skills training materials for this project. Mr. Joseph P. Lamos, Air Force Human Resources Laboratory Technical Training Division at Lowry AFB, was the Technical Monitor, and Dr. Harold F. O'Neil, Jr., was the Program Manager from the Defense Advanced Research Projects Agency for the majority of the contract performance period. Both of these individuals made valuable contributions to the research and development effort. Finally, special appreciation is expressed to the many Air Training Command instructors and supervisors without whose support this project would not have been possible.

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The benefits to be derived from computer-managed instruction (CMI), within the framework of large-scale military technical training, are very promising. CMI is an individualized instructional system in which the majority of the students' instructional activities are completed off-line, in contrast to computer-assisted instruction (CAI) where all instructional activities are conducted on-line at an interactive computer terminal. The computer's role in CMI is that of evaluator, diagnostician, prescriber, and manager of instructional events. Although considerable effort has been devoted to improving the hardware, software, and instructional technology which support CMI systems, the problem of preparing students to utilize their skills effectively and efficiently within this individualized instructional system has received little attention.

It must be assumed, moreover, that until various forms of individualized instruction become common in our public school system, military trainees will find CMI to be an extremely novel learning experience. Few of these trainees will possess the knowledge or skills to enable them to use the capabilities of computer-based systems efficiently. Although there are certainly some basic skills which transfer from one learning environment to another, many trainees either will not have these skills or will not know how to adapt them to CMI training. If the CMI systems being designed and built are to be most effective, there is a definite requirement for orienting students to novel system capabilities and for equipping them with minimum skills to capitalize on these capabilities.

The goals of the CMI Study Skills Project were therefore to:

1. Determine the typical problems which students face in a CMI system and those methods which help students cope with these problems.

2. Design, develop, implement, and evaluate a small set of instructional materials for increasing the effectiveness with which students adapt to and perform in a CMI environment.

3. Design these materials to be as independent from course material as possible such that they could be assigned near the beginning of an arbitrary technical training course.

4. Incorporate strategies or procedures that would continue to affect student behavior throughout the course, e.g., review and practice of a set of basic skills.

Project Context: The Air Force Advanced Instructional System. The context for the CMI Student Skills Modules Project was the Air Force Advanced Instructional System (AIS), developed under the auspices of

the Air Force Human Resources Laboratory Technical Training Division and located at Lowry AFB. The AIS is a prototype, multi-media, computer-based instructional system designed to improve the effectiveness and efficiency of Air Force technical training and to provide an operational research facility for assessing innovations in instructional technology. The system supports four technical training courses representative of the range of cognitive and performance skills required by enlisted Air Force personnel. An adaptive instructional decision model utilizes state-of-the-art computer hardware and software, as well as currently available statistical methodologies and instructional procedures, to provide instructional management and individualized assignments to alternative instructional materials.

AIS Course Structure. Each AIS course is divided into "blocks" of instruction which may require anywhere from 1 to 15 days to complete. Each block contains a number of lessons and a comprehensive, end-of-block test. Within a block, lessons are arranged in a hierarchy based on their prerequisite relationships. A typical hierarchy resembles a set of parallel chains diverging and converging on certain pivotal lessons, and a student may alternately work on lessons in two or more parallel chains.

The basic unit of instruction is the lesson. Each lesson consists of a set of objectives, two or more forms of a criterion test, and typically, a self-test by which the student can evaluate his or her understanding of the lesson before taking the criterion test. A lesson's instruction is provided by one or more modules, each of which teach the same lesson objectives and cover the same lesson content. Where two or more modules are present, they represent alternative instructional treatments or strategies. Depending on the lesson content, objectives, and nature of the treatment, a module may be a programmed text, an elaborated technical order, or an audio-visual presentation.

AIS Student Progress Management Component. The AIS Student Progress Management Component (SPMC) generates target course completion time for each student. These targets are predicted on the basis of the student's abilities, attitudes, interests and background information as measured by a battery of tests given all students prior to course entry.

The initial SPMC printout occurs when the target rate is first computed, following the processing of the student's last preassessment test form. Target times for each block and the student's total course completion time are listed in units of days and tenths of days. This printout is delivered to the student's learning center instructor, and the information on this printout is used by the student in completing the progress monitoring procedures described in the Orientation/Time Management module.

The student's first prescription or Status Report of each day contains the days and tenths of days of the course completed and the days

and tenths of days spent in class. The amount of work constituting a "day" of the course is a function of the student's target rate. Each student's rate of progress is also reported on the learning center roster which instructors receive at the beginning of each shift. Information on the roster includes the number of days and tenths of days remaining to the student's targeted course completion date and the number of days and tenths of days by which the student is ahead of target. A negative value for "days ahead of target" indicates that the student is behind target and provides a means by which instructors can detect students who are falling behind in their course work.

If an instructor decides that a student's target rate should be reset, a target change request can be forwarded to the course Database Manager, who changes student targets through an interactive editor. Although it would have been feasible to alter students' target rates automatically on the basis of their actual rates of progress, specific intervention by the instructor was purposefully required. Given the variety of reasons why students may be behind or ahead of their target rates, it was reasoned that the instructor is in a better position to determine the correct action than is the SPMC software.

PROCEDURES

To determine the typical problems which students face in a CMI environment, students from two AIS courses were interviewed in two phases of the project. During the first phase, students from subgroups defined as "good" and "poor" in each course were asked general questions about (a) their reactions to the CMI environment, (b) features they liked and disliked about this environment, (c) problems they had experienced, and (d) information about that environment which they would have found helpful as new students. "Good" students were those who were completing the course faster than the average student with above average grades. "Poor" students were those who were completing the course at a slower than average rate with below average grades. All selected students were working in the last half of their training course and were selected on the basis of records maintained by the AIS. An Orientation to CMI Module and a Time Management Module were designed on the basis of these initial student interview results.

The second phase of student interviews was conducted after the design and development of the Orientation and Time Management Modules. These interviews focused on specific student study skills problems in a CMI environment. For these interviews, students were selected from subgroups defined as "Experienced Good," "Experienced Poor," "Naive Good," and "Naive Poor." "Good" students were those who were at least 2 days ahead of their Target Completion Date and had at least an 80% grade point average on completed block tests. "Poor" students were those who were 2 days or more behind their Target Completion Date and had less than an 80% grade point average. "Experienced" students were those who had completed all but two blocks of their course, and "naive" students

were those who were still working on the first block of their course.

The results of these student interviews, along with interviews with students who had been eliminated from the course and interviews with instructors and supervisors, formed the basis for the design of a Student Study Skills Package. This package contained a student Study Skills Questionnaire and separate skill training in the areas of Reading Comprehension, Memorization, Test Taking, and Concentration Management skills. Additionally, an Instructor Orientation and Training Workshop was designed to help instructors learn and practice the techniques and strategies in the four Study Skills Modules and to update their basic diagnostic and tutorial skills so that they would know how to identify students who needed help in the study skills area.

ORIENTATION MODULE

The major design goals for this module were to (a) improve students' attitudes toward CMI and (b) reduce course completion time. It was hypothesized that if students were given a solid understanding of novel CMI environment features and instructional procedures, they would have a better appreciation for the benefits of this instructional system and would waste less time trying to figure the system out for themselves. It was also felt that students would begin using the CMI-provided instructional tools earlier in the course and would, accordingly, spend more time learning the instructional materials. A subordinate goal for this module was to provide students with appropriate role models for increasing acceptance of their increased responsibility for learning in a CMI environment.

The Orientation Module can be described as a brief and general introductory package which explains the characteristics of a typical CMI environment. It compares and contrasts these characteristics with those of a conventional lock-step environment and details the behaviors of successful versus unsuccessful CMI students. The module emphasizes that in a CMI environment the student is responsible for learning and that many times negative self-talk is the root of student problems. Finally, this module introduces the concept of time management and its importance in terms of achieving one's goals.

The first evaluation of the Orientation Module was done in a small group tryout during which students and staff read the module and were then interviewed on a one-to-one basis to determine their opinions and suggestions. The results of these tryouts included (a) the mean time to complete the module was approximately 20 minutes, with a range of 16.1 to 23.5 minutes, (b) students expressed a need for embedded questions to be added to the module, (c) students and instructors requested changes to several of the cartoons, and (d) a number of explanations of efficient student behaviors for CMI were in need of clarification. Based on these results, appropriate revisions to the Orientation Module were made prior to operational tryouts.

The second evaluation of the Orientation Module was restricted to the PME course, since evaluations of the Study Skills Modules were scheduled in the other three AIS courses. For approximately 6 weeks, data were collected on block completion times and scores and pre/post Attitude Toward CMI scores, using data from students who entered and completed the second CMI block in the course during this period. To provide an evaluation of the relative effectiveness of an Orientation versus No-Orientation condition, students were randomly assigned to Module 01 or 02, respectively, for this first lesson of the block.

At the completion of the evaluation period, the data showed only nine cases for Module 01 and seven cases for Module 02. When time constraints were applied to exclude unreasonable cases (excessive block completion times), the number of cases for Module 01 dropped to four and the number of cases for Module 02 dropped to six. Analyses on both of these sets of data revealed no reliable differences between the groups on block times, block scores, or attitude measures. These results, although somewhat inconclusive due to the small number of students available for this evaluation, are promising in light of anecdotal data supplied by both students and instructors. That is, comments concerning this module indicated that (a) there was a definite requirement for orienting students to the novel aspects of a CMI environment and (b) the module design was positively received. Furthermore, shortly after this evaluation was completed, the PME course transitioned their entire course to a CMI format and installed the Orientation Module at the beginning of the first block of the course.

TIME MANAGEMENT MODULE

Time Management Module. The major design goal for this module was reduction in course completion time beyond any reduction attributable to the AIS SPMC. Subordinate goals were that (a) students would maintain their individual progress tracking charts on a daily basis, (b) students and instructors would meet for scheduled Progress Counseling Sessions, and (c) students would express positive attitudes toward CMI in general and the SPMC in particular.

The content of the Time Management Module focused on explaining the philosophy, characteristics, and operation of the SPMC and the use of the Course Completion Map. The Course Completion Map is a progress charting technique for promoting self-monitoring and self-management student behaviors in a CMI environment.

The first evaluation of the Time Management Module was conducted in the Inventory Management (IM) course and began with two small-group tryouts in which the main concern was with the mechanics of the module itself. The evaluator worked one-on-one with a total of 42 entering students. In addition to the module, students were given a lesson test and a five-item attitude questionnaire. As a result of these tryouts, a number of minor wording changes were made and additional explanations and examples of daily progress plotting were added.

This was followed by a second evaluation of the Time Management Module. During this evaluation, the Time Management Module became the first lesson in the first block of a special evaluation version of the IM course. The module questionnaire was not administered since a standard Student Attitude Questionnaire was administered at the end of Block 1. During this evaluation, 64 students entered the evaluation version of the course, and of these, 28 completed the first four blocks. The number completing the remaining two blocks of the course was too small for meaningful analysis.

First attempt scores on the lesson test had an average of 88.3 percent. Only one student failed to meet the criterion of 60 percent correct. First attempt lesson times were found to be unreliable due to the lesson's position as the first assignment in the course. Administrative activities required at course entry were being charged against the lesson, and the lesson's position was later changed to avoid these timing errors.

Students' completion times and end-of-block test scores on the first four blocks were compared with those of a comparable group of students entering the course during the same period. The results were considered promising since the average of the evaluation group's total time for the four blocks was 3.75 hours less than that of the control group.

The Time Management Module was then evaluated in a third test. During the first phase of this test, the module, plus the AIS SPMC were compared with a no-module, no-progress-management condition. During the second phase, all students were under the SPMC but only half of them were given the module.

Results of these evaluations revealed time savings of 11.2 percent in Phase I and 9.0 percent in Phase II for the module. The overall effectiveness of both the module and Management Component were conservatively estimated to be in excess of 18.0 percent by the end of the Phase II evaluation. In addition, Phase II results, unlike Phase I results, indicated no negative block scores, block failures, or student attitude results with the combination of Time Management Module and SPMC.

STUDY SKILLS MODULES

The major design goal of the Study Skills Modules was to provide poorly skilled students with appropriate techniques for improving their performance in the course and reduce the amount of time required to complete the course. The four study skills areas which were isolated as being the most troublesome for students were (a) Reading Comprehension, (b) Memorization, (c) Test Taking, and (d) Concentration Management. A set of materials was written for each of these four areas and packaged individually, so that a student could receive any or all of the packages as deemed necessary by an instructor. The modules were also

designed to be consumable (i.e., retained by students) so that students could return to new material to freshen their memories or clarify confusing or difficult areas. Furthermore, since the use of good study skills is an on-going requirement in the course, it was judged desirable to give students a set of materials to which they could refer whenever necessary.

The philosophy behind the techniques described in all four of the Study Skills Modules is that learning new information becomes easier if the student changes the new information in such a way as to make it meaningful to him or her. Thus, the Reading Comprehension Module recommends that students ask questions about the new material they are trying to learn or draw pictures detailing the relationships between the new ideas. The third recommendation of this module is for the student to use a systematic problem-solving procedure to resolve difficult or confusing passages. The Memorization Module describes and exemplifies the use of mnemonics and the Test Wiseness Module discusses the use of logical reasoning strategies and gives students numerous practice exercises in these techniques. The Concentration Management Module discusses the importance of creating a good mood for efficient and effective study and the ways in which negative self-talk can cause numerous problems.

The first evaluation of the Study Skills Modules employed instructors from the four AIS courses, rather than students. There were three main reasons for this procedure. First, it was hypothesized that if instructors were included in the formative evaluation of this package, they would be more accepting of it during subsequent evaluations. Such acceptance was deemed highly desirable due to the substantial instructor resistance experienced during evaluation of the Orientation/Time Management Module. Second, since training in study skill techniques was to be an integral part of the Instructor Orientation and Training, it was thought that instructor participation would be greater if their comments and suggestions were given validity and value. Finally, much of the material which was used in these modules had already been subjected to student evaluations by other researchers.

The results of this evaluation indicated that the instructors generally liked the modules and believed that they would be useful to at least some of their students. They also thought, however, that the modules were written at too difficult a level for most students and, therefore, needed to be revised.

Instructor Orientation and Training was conducted prior to the second evaluation of the Study Skills Modules in order to insure that (a) only those instructors who were committed to the utility of study skills remediation participated in this evaluation and (b) those same instructors were adequately trained to use the materials appropriately. Given that instructor volunteers for these workshops were only obtained from operational AIS blocks in the IM, MF, and WM courses, operational

tryouts of the Study Skills Modules were restricted to these courses. The evaluation period was approximately 10 weeks. During this time, instructors identified students in need of one or more of the Study Skills Modules and assigned them to these modules during the regular shift or assigned the module(s) as homework. To assist instructors in their diagnostic activities, a special AIS interactive program was written for them. This program, when given a student's Social Security Number, displays the student's Study Skills Questionnaire scores.

The results of the second evaluation of the Study Skills Modules were very encouraging. Although the number of cases for this evaluation was small (instructors forgot to record student data in the AIS data base or they did not attend the instructor workshops and therefore did not understand the importance of this activity), the findings of dramatic student improvement in block times and scores following study skills remediation were so consistent as to warrant the conclusion that this training met the goal of increasing student efficiency and effectiveness in a CMI environment. There was also some evidence that providing students with study skills training improved their opinions of their study skills, particularly if the training was given in more than one study skills area. Finally, the results suggested that the time required for study skills remediation compares favorably with the resulting savings in completion time (around a 17 percent reduction in course completion times for those students receiving the Study Skills Modules).

STUDY SKILLS QUESTIONNAIRE

The Study Skills Questionnaire is divided into four sections corresponding to the four Study Skills Modules: Reading Comprehension, Memorization, Concentration Management, and Test Wiseness. For the purposes of this project, the questionnaire was administered twice: after students completed the first block of their course and just before beginning the last block. The results of the first administration of the questionnaire provided a pre-intervention measure and information for instructors as to the type of remediation that would be most appropriate for specific students, and the results of the second administration of the questionnaire provided a post-intervention and evaluation measure.

The first evaluation of the Study Skills Questionnaire consisted of instructor reviews of this instrument. The results of this review indicated that instructors were generally satisfied with the content and format of the questionnaire. The questionnaire was then evaluated a second time and as such was given to all students in the IM, MF, WM, and PME courses as they began the second block of their CMI course and again as they began the last block of their course. Analysis of these data indicated that 30 of the original 50 questions were highly reliable and should be used in the revised questionnaire.

The Study Skills Questionnaire was then subjected to a third evaluation in which data on both the reliability and validity of the questionnaire were collected in the four AIS courses. The results of this evaluation indicated that the questionnaire was highly reliable and able to accurately and consistently predict whether or not students would perform poorly in their course. Performance was measured by block completion times, block scores, lesson completion times, and lesson scores. In addition, although the smaller set of Study Skills Questionnaire variables was not as effective as the larger preassessment variable sets in correctly classifying unsatisfactorily versus satisfactorily performing student groups, the results were encouraging for those CMI environments which do not accommodate preassessment testing. For an environment such as the AIS which does accommodate a preassessment battery, the Study Skills Questionnaire adds another useful dimension of individual difference data.

INSTRUCTOR ORIENTATION AND TRAINING

The Instructor Orientation and Training Workshop has three main objectives: (a) To familiarize instructors with the strategies, techniques, and objectives of the study skill materials, (b) To provide instructors an opportunity to practice these techniques, and (c) To provide instructors with appropriate counseling and tutorial skills. This third objective was deemed important, as one of the major responsibilities of a CMI instructor is considered to be providing one-to-one counseling for students with special learning problems.

The Instructors Workshops consist of three 2-hour sessions. The first session is devoted to explaining, discussing, and practicing the use of the study techniques described in the Study Skills Modules. The second session focuses on problem solving skills, diagnostic strategies, and remediation procedures, including some training in listening and probing skills. These two sessions are held on consecutive days and the third session is held approximately 1 week later. This third session is designed to give instructors a chance to discuss any problems or difficulties they have experienced in using the materials and procedures in their classrooms, to exchange information, solutions, and suggestions and to present interesting case histories.

Evaluation data for the Instructor Orientation and Training Workshop were provided by both the instructor critiques of the workshop, and by instructors' subsequent use of their new skills in the assignment of students to particular study skills materials. Instructor comments from the workshops were generally very favorable, with a majority of the 27 participating instructors indicating that they liked the content and format of the workshops.

Unfortunately, however, not all of these instructors had the opportunity to assign study skills materials to students in their courses due to changes in their duty assignments following the workshop train-

ing. Of the nine instructors in the IM, MF, and WM courses who were able to assign the materials, an average of more than two students per instructor were given Study Skills Module(s) assignments. Judging by discussions with instructors and data clerks in these courses, however, these numbers are misleading in that many more study skills assignments were made but were not recorded in the AIS data base. Thus, it was concluded that the Instructor Orientation and Training was at least moderately successful in promoting the remediation of study skills problems--a finding further substantiated by the consistent improvements in student block times and scores following this remediation.

SUMMARY

Results and Conclusions from Student Skill Modules Project

- The data on the Orientation Module were inconclusive, but anecdotal data indicate the module is of benefit to students.
- The Time Management Module, when combined with the SPMC, resulted in significant reductions in block and course completion times.
- The Study Skills Questionnaire was highly reliable and a good predictor of student performance.
- The data on the Study Skills Modules, although limited with respect to number of samples, point to dramatic and consistent student improvement in block times and scores following assignment to study skills remediation.
- The Instructor Orientation and Training Workshop was well liked by participating instructors and used by them in the classroom for the assignment of students to study skills remediation.
- Some evidence was found that the Instructor Orientation and Training led to improvements in instructor attitudes toward the CMI system and their new roles in that system.

IMPLICATIONS FOR FURTHER RESEARCH

This project has demonstrated the positive benefit of student skill training on reducing the costs of military technical training. There are, however, a number of questions that remain unanswered. This section lists these questions as areas recommended for future research.

1. The need exists to investigate the effectiveness of the Orientation Module in the AIS and/or other CMI technical training environments, with respect to its impact on students' performance and attitudes.

2. Research aimed at individualizing the assignment and/or reassignment of time management skill training is desirable, in that it

has the potential of further increasing student training efficiency and effectiveness.

3. As with student training in time management skills, there is a need to investigate methods for individualizing the assignment of stuc skills training in order to obtain maximum benefit from this type of training.

4. Additional research which pin-points the cut-off scores on the Study Skills Questionnaire which are most reliably related to study performance (times and scores) in CMI technical training courses, as well as to their need for particular types of study skills remediation, is needed to further the utility of this questionnaire.

5. A critical need exists to explore the types of roles required of instructors in a CMI environment, particularly as these relate to their function as facilitators of the learning process, and to provide specialized CMI instructor role training.

RECOMMENDATIONS FOR USE OF MATERIALS PRODUCED IN THIS PROJECT

1. The Orientation/Time Management Modules should be implemented near the beginning of CMI technical training courses to improve student efficiency and attitudes.

2. The Study Skills Questionnaire should be made part of each course's preassessment battery or placed in the first course block, so that it can be used to help identify students with specific study skills problems or those who will have difficulty successfully completing the course.

3. The four Study Skills Modules should at least be implemented in all CMI courses and used by students identified as having study skills problems. Consideration should also be given to using these skill modules in non-CMI Technical Training courses.

4. An Instructor Orientation and Training Workshop in those skills required to effectively use the Study Skills Questionnaire and Modules should become an on-going in-service training program in each course.

SECTION II: SCIENTIFIC DATA SECTION

1.0 INTRODUCTION AND OVERVIEW OF CMI SKILL MODULES PROJECT

Recent innovations in instructional technology offer substantial promise for improving the effectiveness and efficiency of military training. Advances in individualized instructional materials and procedures are especially noteworthy in this regard, particularly those which take advantage of recent concepts emerging from the field of cognitive psychology and its focus on the active information processing capabilities of the learner and strategies for differentially improving the effectiveness of these unique processing skills. At the simplest level of individualization, instructional materials can be designed to allow the student to complete the instruction at his or her own pace. The addition of computer-based instructional procedures enhances the individualization benefits of self-paced instruction by providing the information management capabilities required to implement more adaptive individualized instruction on a large scale.

The promises of individualized instructional materials and computer-based instructional systems for improving training effectiveness and efficiency have been recognized by the Department of Defense as viable means for reducing military technical training costs. Perhaps in no other instructional environment is it more apparent that time equals dollars. Every day of training time saved by innovations in training materials or procedures can result in considerable savings of training dollars and more efficient utilization of manpower in the field.

In the context of large-scale military technical training, benefits to be derived from computer-managed instruction (CMI) are particularly promising. CMI can be defined as an instructional system in which the majority of the students' instructional activities are completed off-line, in contrast to computer-assisted instruction (CAI) where all instructional activities are conducted on-line at an interactive computer terminal. The role of the computer in CMI is that of evaluator, diagnostician, prescriber, and manager of instructional events. Although considerable effort has been devoted to improving the hardware, software, and instructional technology which supports computer-managed instructional systems, the problem of preparing students to utilize their skills effectively and efficiently within this system has received little attention.

While the problem of helping students transition their existing skills to innovative instructional environments is not unique to military technical training, a computer-managed, individualized military training environment provides a rich arena for exploring materials and procedures

designed to ease the students' transition into this new training experience. It must be assumed that until various forms of individualized instruction become common in our public school system, military trainees will find CMI to be an extremely novel learning environment. Few of these trainees will possess the knowledge or skills which enable them to use the capabilities of computer-based systems efficiently. Although there are certainly some basic skills which transfer from one learning environment to another, many trainees will either not have these skills or will not know how to adapt them to computer-managed training. If the CMI systems being designed and built are to be most effective, there is a definite requirement for orienting students to novel system capabilities and equipping them with minimum skills to capitalize on these capabilities.

1.1 Project Goals

The overall goals of the project were to (a) determine the characteristic problems which students encounter in a CMI system and those strategies which effectively help students cope with or adapt to these problems, (b) design, develop, implement, and evaluate a small set of self-contained instructional modules for increasing the effectiveness with which students adapt to and perform in a CMI environment, and (c) investigate procedures for individualizing the assignment of these modules so as to minimize total completion times and training costs.

The student skill modules developed had the design goal of being short packages which could be assigned near the beginning of an arbitrary technical training course, but which also would incorporate strategies or procedures that would continue to affect student behavior throughout the course (i.e., behavioral self-control strategies). Thus, the rationale governing module design was to include those instructional strategies and procedures appropriate not only to the teaching of specific skills, but also to the review and practice of a set of basic skills defined as necessary for effective and efficient student performance in a CMI system.

In the process of module design and implementation, it became apparent that additional mechanisms were necessary to effectively transition the student skill modules into the CMI environment. Instructor understanding and appreciation of the goals and objectives of the project, as well as implementation procedures and strategies involved in the student skill modules were judged to be critical to the potential success of such skill training. For this reason, it was decided to develop an instructor orientation and training package to acquaint CMI instructors with project goals and with the basic diagnostic and tutorial skills required for the individualized assignment of student study skills training materials. This instructor package was, therefore, developed in place of the originally planned computer-based individualization procedures.

1.2 Related Literature

The literature related to the skill training materials developed in this project is selectively reviewed in four sections. The first three sections address factors in three problem areas that are considered to be important in the design of materials: (a) orienting students to novel learning environments; (b) providing students with skills for managing their time in self-paced instructional systems; and (c) providing students with specific study skills required in individualized, self-paced training environments. The fourth section addresses the problem of providing instructor training in skills which will facilitate effective student use of the skill training materials.

1.2.1 Student Orientation to Novel Learning Environments.

On the basis of the literature describing military (Fletcher, 1975; Hansen, Ross, Bowman, & Thurmond, Note 1; Kimberlin, Note 2; McCombs, et al., Note 3, McCombs & Siering, Note 4; Middleton, Papetti, & Micheli, 1974) and non-military (Allen, Meleca, & Myers, Note 5; Cooley & Glaser, 1969; Countermine & Singh, 1974; Danford, 1974; Hagerty, Note 6; King, 1975; Ullery, 1971) CMI environments, the factors that are most novel to the student may usefully be categorized along three dimensions: (a) a physical dimension involving the student's interaction with the physical aspects of the environment, (b) a learning process dimension including those training features which, either through design or accident, have a direct impact on the student's rate of learning, and (c) a social dimension involving those interpersonal dynamics directly related to the preceding factors.

Novelties the student must adapt to in the physical environment include (a) a variety of multi-media materials, (b) learning centers containing 10 to 100 student carrels, (c) a variety of carrel designs from individual to multi-person, which may contain sophisticated equipment, (d) instructor stations or resource centers for obtaining learning materials, (e) testing rooms equipped with reader/printer terminals and/or interactive terminals, and (f) mark-sense answer sheets for testing and requesting student assignments.

In the learning process dimension, the student's new experiences may include (a) assignment of a variety of instructional materials on the basis of the student's characteristics or performance, (b) availability of organizers such as objectives, embedded questions, spaced and massed reviews, (c) frequent criterion referenced testing, (d) individualized pacing, (e) computer scheduling of learning activities and equipment, and (f) unanticipated equipment or computer failures which interrupt the learning process.

The novelties inherent in the social dimension can include (a) less opportunity to discuss course content with peers, since students are at varying points in the course, (b) less opportunity to assess one's own performance relative to others due to the absence of group, norm-

referenced testing, (c) more emphasis on self-responsibility for learning rather than on instructor or peer group, (d) objective (computer) performance evaluations rather than subjective (instructor) evaluations, (e) individual interactions with instructors rather than group-instructor interactions, and (f) computer-assigned seating patterns rather than patterns based on peer relationships.

In her review of the impact of computer-based instruction on education and training, King (1975) notes that negative student attitudes are one set of outcomes that can be modified by systematic orientation to the computer-based system. In fact, King suggests that such an orientation is the most feasible way to elicit initially positive attitudes which are unlikely to change. An orientation program should, according to King, provide an overview of system components and instructional modes to be encountered, avoid overselling the system by presenting a realisitic picture of the system's positive and limiting features, and help students overcome feelings of "machine shyness" by addressing common misconceptions about computer capabilities.

Kopstein and Seidel (1972) discuss factors to be considered in attempting to remove the perceived dehumanizing aspects of a computer-based system. These factors include changing students' initial perceptions from a state of "can't do" to "can do," giving students the feeling that they have a choice in the management of their learning activities, and helping students learn that the system is adaptive to their abilities and needs. Further, they suggest that materials which have a degree of warmth and sensitivity to student needs are one of the most critical ingredients in altering the perception of dehumanization. The successful implementation of such materials, with respect to more positive student attitudes with a computer-based versus traditional math program, is reported by Smith and Hess (Note 7).

Additional factors to be considered in modifying potentially negative attitudes toward a computer-based instructional system are suggested by Khan and Weiss (1973). Their recommendation is that various forms of persuasive communication be used to help students feel they have some choice and positive benefits associated with their learning activities, such as increased feelings of responsibility and determination of their degree of success in obtaining course goals. In a similar vein, Seidel, Wagner, Rosenblatt, Hillelsohn, and Stelzer (1975) suggest that students should be provided initial training in self-management skills to increase their responsibility for their own learning in independent learning environments.

In a quasi-longitudinal study on the relationships between academic achievement and personality characteristics, Kifer (1975) points out that instructional systems which provide for mastery learning and self-pacing can be instrumental in the development of positive personality characteristics in students. Kifer argues that the provision of positive features in the learning environment, such as mastery learning and self-

pacing, provides a means for students to achieve well, thus promoting their sense of self-confidence based on histories of success experiences. The implication of this study for the orientation module design is that students can be helped to see the positive features of a CMI environment in terms of their own growth and development. Similarly, Goldschmid and Goldschmid (1976) have argued that for students to perform effectively in innovative types of instruction, attempts should be made to train them to take advantage of the system by introducing them to the new types of skills required.

Although the literature selectively reviewed in this section is replete with suggestions for the type of information students should be given in an orientation to a novel learning environment, there is a conspicuous absence of studies which have systemmatically investigated the effectiveness of orientation packages with respect to changes in students' attitudes or performance. This is particularly true of packages designed to orient students to the novel features of a CMI environment.

1.2.2 Time Management Skill Training. Several of the studies mentioned in the preceding paragraphs stressed the importance of self-management skills in a self-paced, computer-based instructional environment (e.g., Khan & Weiss, 1973; Seidel, et al., 1975). While there are a number of interesting "self-help" books on time management techniques in the popular literature (e.g., Lakein, 1974), approaches to teaching time management skills in the educational/psychological literature are sparse at best. One reason for this dearth of research is the traditional concern with level of achievement rather than learning times. When emphasis is placed on student efficiency in an individualized instructional situation, time management skill training becomes more critical.

The need for training in time management skills in an individualized instructional system is suggested by Carpenter (1971). She lists the following as desired outcomes of individualized instruction: (a) optimum student motivation and interest, (b) optimum types and difficulty levels of materials and methods, (c) optimum adaptation to student responses, (d) optimum scheduling and pacing of student activities, and (e) optimum shifts from external control to self-regulated learning activities. To obtain these outcomes, a module for training students in time management skills for a self-paced, computer-based training environment should address strategies for efficiently pacing oneself and making the shift from external control to self-regulated learning.

A number of recent studies have investigated the differential effectiveness of student-paced versus instructor-paced groups in personalized systems of instruction. For example, Reiser and Sullivan (1977) examined the performance of student and instructor-paced groups of undergraduate political science students on unit quizzes and final exam

scores. In the self-paced group, students could take unit quizzes whenever they chose, while in the instructor-paced groups, students took the quizzes on target dates set by the instructor. Results of interest included (a) significantly more self-paced than instructor-paced students withdrew from the course, (b) instructor-paced students tended to score higher on the final exam than self-paced students, but quiz scores did not differ between the groups, and (c) instructor-paced students tended to have more favorable attitudes toward the course than self-paced students. Reiser and Sullivan attribute these results to the fact that self-paced students lacked the necessary skills to pace themselves consistently. Thus, these results support the need for time management skill training in self-paced environments and for some form of targeting system for helping students achieve a steady and consistent pace.

Consistent with the latter suggestion, Pascarella (1977) compared course achievement and attitudes of university calculus students who were randomly assigned to a personalized system instruction (PSI) versus conventional classroom groups. In the PSI group, students were given a suggested schedule for completing unit tests to help reduce procrastination, whereas conventional students had a formal unit test schedule. In contrast to the Reiser and Sullivan (1977) study, Pascarella found that PSI students had higher scores than conventional students on both course achievement and attitude measures. These findings support the importance of providing a targeted completion schedule for reducing student procrastination and improving performance in a self-paced environment.

Two additional studies which compared student versus instructor-paced groups in personalized instructional systems were conducted by Fernald (1975) and Bijou, Morris, and Parsons (1976). In the Fernald study, introductory psychology course undergraduates were assigned to one of three PSI feature combinations: (a) teacher or student pacing, (b) perfection or no perfection requirement, and (c) much or little social contact with an undergraduate teaching assistant (TA). Results indicated that student-paced groups scored higher on weekly quizzes but not on midterm exams than teacher-paced groups, students preferred TA contact and student pacing over no TA contact and teacher pacing, and the perfection requirement did not significantly affect student performance. Contrary to these findings, Bijou et al. set up a weekly point system for rewarding students who stayed on schedule in an undergraduate PSI child development course, and found no performance differences for self-paced versus instructor-paced groups. Bijou et al. also found that the point system students paced themselves evenly through the course materials, while the no-point system students procrastinated. These findings suggest that external reward systems may be as effective as a targeting system for reducing student procrastination in self-paced systems.

In the area of studies which have examined various self-monitoring strategies in self-paced PSI environments, Croft, Johnson, Berger, and

Zlotlow (1976) investigated the effectiveness of (a) weekly monitoring of course progress by instructor, (b) bi-weekly monitoring of course progress by instructor, (c) self-monitoring by students, and (d) no monitoring. In a comparison of the number of testing sessions required to complete the course and total points earned, Croft et al. found that students in all monitoring conditions performed better than students in the no-monitoring condition on both performance measures; however, no discernible differences were established between the monitoring conditions.

A similar study on the effects of various self-monitoring conditions in an undergraduate PSI course was conducted by Yates and Zimbardo (1977). In this study, students were assigned to one of four conditions: (a) a self-monitoring group, who charted daily and cumulative time spent studying course-related materials, (b) a surveillance self-monitoring group, who additionally had to present their charts weekly to teaching assistants, (c) a group that received incentive points in addition to self-monitoring and surveillance by a teaching assistant, and (d) a control group who did not monitor their studying and were not informed of experimental manipulations. The results of this study indicated that only students in conditions (b) and (c) performed better than control students on unit tests, suggesting that some type of surveillance of time management skills is required.

Myers (Note 8) reviewed a number of studies indicating that students' learning and study behaviors can be significantly modified by self-monitoring techniques, such as having students observe, record, and/or graph their study activities. On the basis of this review, he investigated the relative effectiveness of (a) self-monitoring, (b) a combination of self-monitoring, self-reinforcement, and self-punishment, and (c) no monitoring on the midterm examination performance of male and female college students in chemistry and calculus classes. Relevant findings were that self-monitoring alone was as effective or moreso than the combination of self-monitoring, self-reinforcement, and self-punishment in both improving students' test performance and increasing their reported study times. These findings suggest that the use of self-monitoring strategies such as charts or graphs should help maintain desirable time management skills throughout a self-paced course.

In addition to studies on strategies for assisting students to become more self-regulated and responsible for their learning, the effects of giving students data on completion times in a self-paced system are relevant. Johnson, Salop, and Harding (1972) found that Navy students given predicted times and incentives based on whether they completed lessons in less time than was predicted completed the course in 17 percent less time with no differences in final performance, as compared with control students. There were, however, attitude differences between the two groups which suggest that quite different motivational factors may have been operating. In a similar vein, Colton (1974) compared time and achievement scores of college students who

were or were not given information about how long it took other students to finish 22 self-paced, criterion referenced tasks. Students given time information completed six tasks in significantly less time, but performed significantly less well on the criterion tests than did students not receiving the completion time information. These results suggest that time management skill training is more effective in the context of an instructional environment in which targeted completion times and rate of progress information are balanced with the importance of maintaining required achievement levels.

Two related studies investigated the effects of goal-setting instructions on student achievement in conventional courses. Gaa (Note 9) gave one group of tenth grade English class students weekly individual goal-setting conferences, during which they set goals for the next week's activities and received feedback on their performance and progress in attaining previous goals. A control group did not have the conferences, but received the same in-class instruction. Students in the goal-setting group had higher criterion test scores and attitudes toward the course than control group students. In discussing the attitude data, Gaa interpreted the results to mean that the goal-setting group had higher motivation. In addition, goal-setting students increased their feelings of internal locus of control as compared with control students. Freeman and Niemeyer (Note 10), on the other hand, found no significant differences in criterion test scores as a result of goal-setting instructions.

Anderson (1976) investigated the differential effectiveness of mastery and non-mastery learning strategies in altering students' time-on-task-to-criterion. When provided extra help (student tutors) in early course units and a mastery learning strategy (85 percent correct on within-unit tests) with built-in review procedures, students with lower entering skills attained equality with higher ability students on both attainment levels and amount of on-task time-to-criterion by the end of the third unit. In addition, students in the mastery learning condition spent less time on task following this early tutorial help than did students in the non-mastery condition. These findings imply that early task-relevant skill training "costs" are amortized quickly when students begin using these skills to improve their performance. This suggests that early training in time monitoring and management can, on its own merits, reduce total training time by increasing the time students spend on task-relevant versus task-irrelevant activities. Combining this skill training with completion time predictions and progress feedback (as described by Johnson et al., 1972) could then be expected to result in even greater time reductions.

1.2.3 Study Skills Training. Poore and Pappas (Note 11) point out that ineffective study is one of the most serious and persistent problems students have, regardless of ability level. It is reasonable to expect that study problems would be compounded in the novel environment of CMI. Support for the prevalence of study skills problems is provided by

several recent studies which have attempted to modify students' study habits and skills by a variety of training approaches. For example, Briggs, Tosi, and Morley (1971) examined the effects on subsequent grade point average (GPA) of exposing twenty freshmen women classified as having a deficiency in entrance exam scores, high school grades, or class rank to either an experimental study program or a no-treatment control condition. Over a 5-week period, experimental students were first exposed to procedures in which they incrementally increased their study time in each of five courses to 1 hour per day. After coming up to 1 hour of study time per day per course, the Survey-Question-Read-Recite-Review (SQ3R) study method was introduced to help the students use their study time more efficiently. At the end of the semester, experimental students had significantly higher GPAs than control students in the five academic areas.

McReynolds and Church (1973) investigated the relative effectiveness of regular counseling, experimental self-control counseling, experimental study skills development, and a no-treatment control condition for improving study skills scores, grade point average, reading scores, and Rotter I-E scale scores for college underachiever volunteers. The regular counseling group received general academic counseling; the self-control group received training in the rationale and use of self-contracts for managing and reinforcing study goals and behaviors, as well as training in the general study techniques of the Robinson SQ3R study method; the study skills group received in-depth training in the Robinson SQ3R study method for a total of 10 treatment sessions. Results of interest were that (a) students in the two study counseling groups had improved study skills scores as compared to the regular counseling and control groups, (b) students in the two study counseling groups had improved GPAs as compared to the regular counseling and control groups, with more improvement for the study skills group than for the self-control group, and (c) no differences were found between the groups on I-E scale scores or reading test scores.

A similar study by Groveman, Richards, and Caple (1977) compared the relative effectiveness of six conditions for improving GPAs: (a) no treatment control, (b) attention-placebo control, (c) study-skills counseling, (d) lengthened study skills counseling, (e) behavioral self-control, and (f) behavioral self-control plus study skills counseling groups. The study skills counseling consisted of group sessions in which students were taught skills in textbook reading, study scheduling, note taking, test taking, and writing. The self-control training emphasized self-monitoring, progressive relaxation, stimulus control, self-instruction, and self-reinforcement skills training. Experimental sessions met for 2 hours per week over a 4-week period or for 4 hours per week over a 4-week period for groups (d) and (f). Due to methodological problems of having only one therapist for all experimental conditions, the results of this study were suggestive rather than definitive, with marginal significance levels. The only finding reaching significance was that students in the behavioral self-control

treatments had improved GPAs as compared to the other groups. These findings do suggest, however, the potential viability of study skills training and behavioral self-control training for improving student self-management skills.

Two additional studies suggestive of the effects of study skills training were conducted by Larkin and Reif (1976) and Gadzella, Goldston, and Zimmerman (1977). In the Larkin and Reif study, college physics students were taught general skills for studying scientific text, including how to state the characteristics of relations, give examples, interpret relations, make discriminations, and use equivalent forms of the relation to find or compare values. This training was accomplished by textual materials which introduced new relations, asked questions about the relation which required active student demonstration of the preceding abilities, and provided correct answer and explanatory feedback. A control group learned the course materials as they normally would. Major findings were that students with skill training (a) significantly improved students' ability to acquire understanding of new relationships as compared to control students, (b) were able to effectively apply their new skills to the remaining physics textual materials and were less dependent on extensive instruction, and (c) retained their new skills, as assessed by a 2-week followup measure. Implications of this study are that although the initial skill training required some student effort, this effort paid off in increased student efficiency in subsequent instruction. In addition, the authors point out that since students do not acquire these types of learning skills automatically, direct training of relevant skills is necessary.

In the Gadzella et al. (1977) study, the effectiveness of giving academically successful college students study technique guides and quizzes, with respect to changing their perception of their study skills or their semester grade point average, was investigated relative to matched control students. Results of interest were that although students in the two groups did not differ in semester grade point average, students' perceptions of their study skills become more positive for the study skills training group. The authors suggest that this increased confidence in their study skills and insights which the students received on how they could improve their study skills are well worth the additional time required for study skills training. Thus, even though no performance gains were found, there would appear to be an advantage in improved student attitudes and confidence regarding their skills as a long-term effect of study skills training.

The work of Dansereau and his associates suggests that there are many components of good study skills behavior that should be taken into account in attempts to improve student performance through specialized training in skills relevant to CMI environment requirements (Dansereau, Actkinson, Long, & McDonald, 1974; Dansereau, Long, McDonald, & Actkinson, 1975; Dansereau, Long, McDonald, Actkinson, Ellis, Collins, Williams, & Evans, 1975; Dansereau, Long, McDonald, Actkinson, Collins,

Evans, Ellis, & Williams, 1975; Dansereau, Collins, McDonald, Diekhoff, Garland, Holley, Evans, Irons, & Long, 1977; Dansereau, Note 12). For example, Dansereau's learning strategy materials cover such topics as creating a good mood for learning, self-coaching skills, concentration management techniques, general study skills and strategies, and test-taking skills. In a recent discussion of the results of this type of skill training, Dansereau (Note 12) reports that such training can have a dramatic effect on improving student skills, but the need still exists to demonstrate the effectiveness of such training in terms of course performance gains.

Weinstein (Note 13, Note 14, Note 15) has stressed the importance of improving student skills for remembering and processing information, as a study skill area directly related to learning outcomes. She has developed materials and procedures for teaching students the use of various mnemonic devices, sentence and imaginal elaboration techniques, analogies, paraphrasing, and techniques for drawing implications and creating relationships. The key concept in these materials is that of having the learner become actively involved with the information to be learned, such that the material becomes personally meaningful. Additionally, the skill training materials are designed to be generalizable to a wide range of subject matter areas.

The training materials developed by Dansereau and Weinstein capitalize on recent advances in learning theory and a growing body of empirical research derived from the new focus of cognitive psychology and information processing approaches on the active role of the learner in the learning process. A major proponent of applying this framework to learning is Wittrock (1974) and Wittrock and Lumsdaine (1977), who has advanced a generative model of learning. A basic premise of this model is that learners tend to generate their own meanings and perceptions about materials to be learned and that these meanings and perceptions will be consistent with their prior learning. This generative model of learning is consistent with cognitive theory and has major implications for the design of skill training materials addressed at improving students' study skills.

A recent study by Doctorow, Wittrock, and Marks (1978) demonstrates the success of active information processing strategies. It was predicted that reading comprehension would occur when students were required to actively generate their own sentences about story paragraphs. As predicted, the results of two experiments indicated that the combination of inserted paragraph headings and instructions to generate sentences approximately doubled reading comprehension and recall as compared to a control condition. Frase (1977) and Johnson (1974) have also stressed the importance of active information processing approaches for enhancing student learning.

Additional evidence for the effectiveness of learning strategies which actively involve students in the material or assist students in

making the information to be learned more meaningful to their existing cognitive structures is provided by an increasing number of empirical studies. These studies embody a wide variety of active learning strategies, including (a) visual or verbal elaboration strategies (e.g., Andre & Sola, 1976; Delaney, 1978; Hunter, 1977; Lyon, 1977; Rasco, Tennyson, & Boutwell, 1975; Snowman & Cunningham, 1975), (b) generative underlining or sentence generation strategies (e.g., Bobrow & Bower, 1969; Frase & Schwartz, 1975; Rickards & August, 1975), (c) serial rehearsal training strategies (e.g., McCauley, Kellas, Dugas, & DeVellis, 1976), (d) meaningful semantic processing strategies (e.g., Anderson, Goldberg, & Hidde, 1971; Bellezza, Cheesman, & Reddy, 1977; Mistler-Lachman, 1974; Postman & Kruesi, 1977), (e) note taking or reorganization strategies (e.g., Arkes, Schumacher, & Gardner, 1976; Carter & VanMatre, 1975; Fisher & Harris, 1973; Shimmerlik & Nolan, 1976), (f) problem-solving strategies (e.g., Olshavsky, 1977), and (g) self-reference strategies (e.g., Meichenbaum, 1975; Rogers, 1977). Good literature reviews in this area are provided by Bernstein (1973), Faw and Waller (1976), and Shimmerlik (1978).

A final area of concern in study skills training involves the learners' test-taking skills. This area is particularly relevant to the requirements of a CMI environment, where the number of tests students must take are substantially more than required in conventional classroom environments. The development of a Test-Wiseness program to improve students' general test-taking skills is described by Woodley (Note 16). A combination of text and workbook materials provide students with general suggestions and individualized practice in applying specific test-taking strategies. Individualization is provided by means of specialized diagnostic and branching routines within the text and workbook. In a preliminary pre-posttest evaluation of this Test-Wiseness program, Woodley (Note 16) found that students improved their test-taking skills as measured by a test-wiseness scale. Gross (1977) reports the results of a similar study in which eighth grade students who were taught three test-wiseness behaviors (risk taking, deductive reasoning, time using) improved both their test-wiseness behaviors and standardized achievement test scores, as compared to students who had not learned these skills.

1.2.4 Instructor Orientation and Training. A major determinant of student success in acquiring skills necessary in a self-regulated, self-paced environment such as CMI, is the quality of the student-instructor tutorial relationship. This quality, in turn, is very much dependent on the instructor's understanding of, attitude toward, and skills in the new instructor roles required by self-paced and CMI systems. Although the literature reviewed in this area contains a number of suggestions for defining the role of the instructor in a CMI environment, as well as some suggestions for areas to be covered in specialized CMI instructor training programs, the description of existing programs and/or data pertaining to their effectiveness are conspicuously absent. Thus, the literature selectively reviewed in this

section will focus on those articles or reports which describe instructor roles and skills required in CMI, and on suggested training procedures.

In support of the criticality of the instructor's attitude and role in the successful transition of students to a CMI environment, McMillan (1977) discusses the importance of instructor feedback to the formation of positive student attitudes toward the instructional environment. In his study, male and female undergraduates were given high and low effort assignments within praise and no-praise instructor feedback conditions. Of primary interest were the effects of these conditions on the formation of positive attitudes toward the learning materials, classroom climate, degree of effort in performing the assignments, instructor knowledge and attitude, and content of the learning assignments. The results indicated that the attitudes of students in the no-effort condition were not differentially affected by the feedback versus no praise feedback conditions, whereas praise was found to significantly improve the attitudes of the high effort condition students. The major implication of these findings is that with the new demands and performance requirements inherent in a self-paced, CMI environment (high effort condition), the instructor's role as supporter and facilitator of positive student feelings toward the system becomes critical. In addition, Wittrock and Lumsdaine (1977) point out that in an instructional environment in which the learner is responsible for his own learning, the instructor's role must become one of being responsible for changing the learner's inappropriate attribution of success or failure, and helping the learner attend selectively to the information to be learned and construct meaning from it. That is, the instructor should facilitate student acquisition of active information processing strategies and skills.

A number of researchers have discussed the transition of instructor role requirements from those required in conventional classrooms to those required in computer-based environments. For example, Falzetta (1973) points out that, ideally, the computer frees the instructor to assist students in becoming more skilled and responsible human beings. The instructor's role becomes one of guiding the student to a love of learning and, as such, provides the humanization qualities in this new learning environment.

More specific delineation of the range of roles required in a computer-based environment are also outlined by a number of other researchers in the area (e.g., Bunderson, Note 17; Dyer, 1972; Campbell, Note 18; Kooi & Geddes, 1970; Hansen & Harvey, 1970; Harvey, 1978; Lamos, 1971; Stanchfield, Note 19; Wilson, Note 20). There is fairly general consensus that new instructor roles include (a) diagnostician of individual student learning problems, (b) prescriber of special learning activities, (c) manager of instructional resources, events, or student progress, (d) learning psychologist, counselor, and advisor, (e) subject matter expert, and (f) author of instructional software. Opinions

differ, however, as to the relative importance of each role and the percentage of time instructors need to spend performing the duties required by each role. For example, some researchers place emphasis on the learning diagnostician/counselor/advisor role (e.g., Campbell, Note 18; Hansen & Harvey, 1970), while other researchers emphasize the importance of the instructional manager/designer role (e.g., Bunderson, Note 17; Dyer, 1972).

Given the rather radical shifts in roles from conventional to computer-based environments, it can be expected that instructors will have doubts, fears, or negative attitudes toward these new roles--particularly if they lack the skills and knowledges required to adequately perform them. Hansen and Harvey (1970) detail the nature of these role changes and state that instructors will be doing more strategizing, managing, individual counseling, discussing, specializing, and diagnosing functions and fewer correcting, lecturing, and disciplining functions. The essential nature of these roles in facilitating the students' learning is stressed by Lamos (1971), along with the importance of instructors accepting the challenge of making these new roles at least as interesting and stimulating as their conventional roles.

A recent study by Campbell (Note 18) is particularly relevant in that he analyzed new instructor roles within the Air Force Advanced Instructional System (AIS). In discussing the shift in instructor roles from lecturer, test giver, test corrector, giver of grades to that of a training guidance counselor and advisor of students, Campbell points out instructors will be faced with even greater challenges in their new AIS roles. He stresses the fact that instructors are not only key instruments in the successful implementation of instructional technology, but will continue to be the key in effectively causing learning. Thus, the importance of adequately preparing instructors for their new role requirements is apparent.

Although a number of researchers have stressed the importance of adequately training instructors in their new roles in computer-based environments and the need for such training programs (e.g., Hansen & Harvey, 1970; Hursh, 1976; Stanchfield, Note 19; Wilson, Note 20), the literature contains few examples of the content and procedures to be used in such training, or the relative effectiveness of various training approaches. The seriousness of this situation is reflected in Hursh's (1976) discussion of effectiveness data for personalized systems of instruction, and his conclusion that this effectiveness is related to the adequacy of instructor training in the specific behaviors required.

One example of a training program relevant to CMI instructor skills is provided by Cohen, Emrich, and deCharms (1977). Teachers were taught to differentiate among four possible teaching styles and encouraged to use those styles which fostered more positive personal causation skills (e.g., independence, responsibility for own learning) in students. Elements of teaching styles felt to foster personal causation included

a flexible approach to learning which stimulates problem solving behaviors, exploration of learning alternatives, and active, cooperative classroom activities. Results of this study indicated that whereas teachers demonstrated knowledge of the styles, they did not later transfer the behaviors learned in the workshops to the classroom. Cohen et al. argue this was because one cannot assume that if someone knows new skills, they also want to, and know how to, apply them. Thus, it is stressed that any successful teacher training program should cover three components--that it should move beyond merely cognitive understanding to the want to, know how to, and try to dimensions.

In a similar study, Gall, Ward, Berliner, Cahen, Winne, Elashoff, and Stanton (1978) examined the effects of three specific teaching skills (redirection, probing, and higher order cognitive questioning) on student learning, using 336 sixth grade students. Their results suggest that training packages for teachers are most effective when they provide generalizable skill training, rather than training in discrete skills required in specific teaching situations. Two programs suggestive of the types of generalizable skills required in individualized instructional situations are reported by Cadenhead (1976) and Rash and Grimm (1976). Cadenhead describes a pilot teacher training program in which teachers were taught four primary roles: diagnostician, facilitator, interactor, and innovator. Rash and Grimm, along with describing the implementation of a new self-directed learning program for junior high school students, describe a preservice teacher training program to prepare teachers for the changes they must make in their instructional practices. This training program included team planning activities in which teachers practiced acting as student learning advisors and practiced planning student learning activities, establishing student performance criteria, and planning strategies to increase the effectiveness of each student's learning program. These programs, then, support the feasibility of workshop formats for training teachers in new skill requirements, including the use of group process variables to stimulate instructor involvement and interest, and practice exercises to help insure the transfer of new skills to the instructional environment.

1.2.5 Summary of Literature Review. This selective literature review focused on that literature suggestive of areas and approaches to be used in the development of student skill training materials and instructor orientation and training procedures designed to facilitate student adaptation to a computer-based training environment. Some of the major implications derived from this review for the present project are summarized as follows.

1. A training package for orienting students to the novelties of a computer-based environment should present a realistic overview of system components, address common misconceptions about computer capabilities, describe the behaviors required in the new environment, stress the self-directed and self-management skills required, and have a style which is warm and sensitive to student needs. Such a package

would be expected to elicit positive student attitudes toward the system, which would hopefully be reflected in improved student performance.

2. The training of students in those skills required to manage their time efficiently and effectively should address such areas as the learner's responsibility in a self-paced system, setting time and performance goals, establishing regular contacts with the instructor to discuss progress, procedures for monitoring and charting rate of progress to help maintain time management skills throughout the course, as well as the specific skills involved in efficiently completing course objectives. The literature also suggests that such training is most effective when combined with system or instructor generated completion time targets. Such a time management package would be expected to result in improved training efficiency, in the form of reduced course completion times, as compared with the absence of the package.

3. Training in the specific student study skills required in a self-paced, computer-based instructional system should emphasize the importance of behavioral self-control techniques, as well as train students in active information processing approaches that will allow them to become actively and meaningfully involved in the material to be learned. Specific study skill areas suggested by the literature as potentially relevant to a computer-based environment include training in reading comprehension skills, memorization skills, concentration management skills, and test taking skills. Specific study skills training for students deficient in particular skill areas would be expected to improve both student achievement and progress.

4. Orientation and training of instructors in those skills required to facilitate student learning in a self-paced, computer-based environment should focus on those roles most directly involved in the student-instructor tutorial relationship, i.e., those skills required in their roles as diagnostician, tutor, and prescriber of instructional events. Additionally, instructor orientation and training should include those procedures and strategies most conducive to the formation of positive instructor attitudes and the transfer of their new skills to the training environment (e.g., workshop format to foster positive group processes, active participant involvement and practice of skills in representative examples). This type of instructor orientation and training procedure would be expected to facilitate student acquisition of skills required in the CMI environment.

1.3 Project Context: The Air Force Advanced Instructional System

The context for the Computer-Managed Instruction Student Skills Project was the Air Force Advanced Instructional System located at Lowry Air Force Base, Colorado. The Advanced Instructional System, or AIS, is a prototype, multi-media, computer-based instructional system designed to improve the effectiveness and efficiency of Air Force

technical training and to provide an operational research facility for assessing innovations in instructional technology. The system supports four technical training courses representative of the range of cognitive and performance skills required by enlisted Air Force personnel. An adaptive instructional decision model utilizes state-of-the-art computer hardware and software, as well as currently available statistical methodologies and instructional procedures, to provide instructional management and individualized assignments to alternative instructional materials.

1.3.1 AIS Course Structure. Each AIS course is divided into "blocks" of instruction which may require anywhere from 1 to 15 days to complete. Each block contains a number of lessons and a comprehensive, end-of-block test. Within a block, lessons are arranged in a hierarchy based on their prerequisite relationships. A typical hierarchy resembles a set of parallel chains diverging and converging on certain pivotal lessons, and a student may alternately work on lessons in two or more parallel chains.

The basic unit of instruction is the lesson. Each lesson consists of a set of objectives, two or more forms of a criterion test, and typically, a self-test for student evaluation of his or her understanding of the lesson before taking the criterion test. A lesson's instruction is provided by one or more modules, each of which teach the same lesson objectives and cover the same lesson content. Where two or more modules are present, they represent alternative instructional treatments or strategies. Depending on the lesson content, objectives, and nature of the treatment, a module may be a programmed text, an elaborated technical order, or an audio-visual presentation.

1.3.2 AIS Student Scenario. A student's first experience with the AIS is when he or she is administered a course-specific preassessment battery consisting of cognitive and affective measures considered to be predictive of students' performance in the course. Preassessment test forms are processed at an AIS management terminal and the student's initial course completion time and targeted days per block are printed out.

Following preassessment, the student requests his or her first assignment by submitting a Forward-Going Assignment request at a management terminal. At this point, the student is enrolled in the course but has not yet entered a block containing actual course content. First, therefore, the System selects the block in which the student is to start work. Since the student has not yet completed any course work, only those blocks which have no prerequisites are selected. The student is then assigned to an appropriate learning center and home carrel. Finally, the student is assigned a specific lesson and an alternate form of that lesson's criterion test.

Lesson assignments are determined by two major components of the

System--the Adapter and the Resource Allocation Model. The Adapter attempts to select, for each student and for each assignable lesson, the one module or instructional treatment which is most appropriate for that student. This decision can be based on a variety of rules, e.g., select the module which the student is predicted to complete in the shortest time given a predicted passing score on the criterion test. Each alternative module is given a weight indicating its relative preference. Alternatively, the Resource Allocation Model assigns preference weights to modules for which the required resources are available, in order to minimize the assignment's impact on the availability of instructional resources. Final lesson and module selection is based on a compromise between the two sets of preference weights.

Having received the first printout (Student Status Report), the student reports to an instructor in the learning center assigned, obtains the instructional resources required for the assigned lesson and module, and begins work at the assigned home carrel. After studying the lesson materials, the student completes a multiple-choice lesson self-test and reviews the material pertaining to questions answered incorrectly. The student completes the version of the lesson criterion test assigned and submits the test form to a management terminal. The resulting Student Status Report details the student's performance on the criterion test (percentage total score, items missed, objectives failed, and the pass/fail decision) and gives the next assignment. If the test criterion was not met, the student is reassigned the same lesson and an alternative version of the criterion test. Otherwise, the lesson, module, and test selection procedures are repeated and a new lesson assignment is given.

When the student has completed all lessons in the block, a Block Review lesson is assigned. When the student indicates readiness for the block test, one of the alternate forms of this test is randomly assigned. While lesson tests can be viewed as primarily diagnostic tools, end-of-block tests serve a certification function. If the student does not meet the block test criterion, he or she is reassigned to the block in a status whereby assignments are made by the instructor rather than by the System. If the block decision is "go," the block selection logic is repeated and the next block of study is assigned.

The student's continued progress through the course is essentially a repetition of the proceding events. Two exceptions are that questionnaires designed to assess students' attitudes toward the AIS are assigned following the first and last blocks in the course.

1.3.3 AIS Student Progress Management Component. During the design and development phases of this project (early to mid 1977), software to support a Student Progress Management Component (SPMC) had been designed and was being developed. Prior to that time, the AIS supported a simple form of student progress monitoring and reporting which was recognized as being inadequate, one major concern being that it was not

individualized. In addition, three specific problems shaped the characteristics of the SPMC. First, the general opinion was that AIS students could, if motivated, complete more course work than they were doing during the regular, 6-hour shifts. A related concern was to increase the amount of work students completed off-shift. Lessons were sometimes voluntarily completed out of class, and students who failed one or more block tests were assigned off-shift remedial training. If, however, a student passed the block tests and progressed at a "reasonable" pace, there was no pressure to continue work off-shift. The third problem concerned prediction of course completion dates. Students' anticipated course completion dates were needed 10 days in advance for "out-processing," but variability in the time to complete was so great that useful predictions required unattainably high correlation coefficients.

The SPMC was intended to address each of the foregoing problems, as well as the students' expressed desire for some method for measuring their progress which was uniform throughout the course (see Sections 2.1.1.1 and 2.1.2.1 of this report). The software for the SPMC was to generate a target course completion time for each student which was predicted on the basis of pre-course ability, attitude, interest, and background information; and which assumed that some lessons would be completed as homework. Daily feedback was to be provided to the student and to the student's learning center instructor, and remedial training was to be assigned on the basis of poor rates of progress relative to each student's target or following block test failures. Course managers were to employ available positive and negative incentives to manage students to on-target course completion.

As the SPMC was implemented within the AIS, a student's course completion time is predicted by a multiple linear regression equation employing data from each course's preassessment battery. A "Policy Function" converts this predicted time to a target time. If, for example, course management has determined that course completion times can and should be shortened by 5 percent, students' target times are set to 95 percent of their predicted course completion times. After a number of additional steps which allow for various paths through the course and changes in course content, the end result is an individualized target rate, in the form of a standard score, corresponding to the student's target course completion time.

Time spent in the course is updated when the student completes an assignment and the target time for the amount of work completed is updated when progress feedback is requested. The difference between these two times is the extent to which the student has deviated from his or her target rate.

The initial SPMC printout occurs when the target rate is first computed, following submission of the student's last preassessment test form. Target times for each block and the student's total course com-

pletion time are listed in units of days and tenths of days. This printout is delivered to the student's learning center instructor and the information on this printout is used by the student in completing the progress monitoring procedures described in the Time Management Module (see Section 2.0 of this report).

The student's first Status Report of each day contains the days and tenths of days of the course completed, and the days and tenths of days spent in class. The amount of work constituting a "day" of the course is, of course, a function of the student's target rate. Each student's rate of progress is also reported on the learning center roster which instructors receive at the beginning of each shift. Roster information includes the number of days and tenths of days remaining to the student's targeted course completion date, and the number of days and tenths of days by which the student is ahead of target. If "days ahead of target" is negative, the student is behind target and instructors can easily detect students who are falling behind in their course work.

If an instructor decides that a student's target rate should be reset, a target change request can be forwarded to the course Database Manager, who changes student targets through an interactive editor. Although it would have been feasible to alter students' target rates automatically on the basis of their actual rates of progress, specific intervention by the instructor was purposefully required. Given the variety of reasons why students may be behind or ahead of their target rates, it was reasoned that the instructor is in a better position to determine the correct action than is the SPMC software.

2.0 ORIENTATION TO CMI AND TIME MANAGEMENT SKILL TRAINING

2.1 Problem Definition

To determine the characteristic problems students experience in a CMI environment and further define training requirements for an Orientation to CMI Module and Time Management Module, a series of student interviews were conducted in the first phase of the project. Students selected for these interviews were from one of four groups from the Inventory Management (IM) or Materiel Facilities (MF) courses: (a) IM-Good, (b) IM-Poor, (c) MF-Good, (d) MF-Poor. "Good" students were those completing the course faster than the average rate with above average grades, and "poor" students were those completing the course at a slower than average rate with below average grades. All selected students were working in the last half of the course and were selected on the basis of AIS records.

The interviews were semi-structured discussions wherein the investigator asked a set of predetermined open-ended questions on a one-to-one basis. Twenty IM students and six MF students were interviewed for approximately 30 minutes each. During the interview, discussion centered around the AIS in general and the student's specific problems in the

course. The results of student responses to the 18 questions are summarized in Table 1.

Conclusions drawn from these interviews were as follows: (a) students need a method of measuring their progress which is uniform throughout the course, (b) in conjunction with progress measurement, students need to be taught some basic time management skills, (c) students need to be given information on what to expect in an individualized, computer-managed course, and (d) students need to be told that trying for the best possible grades, without appropriate concern for learning time, is not necessarily the way "to do better" in a CMI course.

2.2 Module Design and Development

A complete description of the concepts and procedures used in the design and development of the Orientation to CMI Module and the Time Management Module can be found in AFHRL Technical Report No. AFHRL-TR-79-14, along with a copy of the instructional materials and evaluation instruments. Thus, the present report will provide only brief descriptions of the objectives of each of these modules, the instructional strategies used and the module formats.

The Orientation to CMI Module was designed to be assigned to students at the beginning of their training course and to serve as the first part of an Orientation Lesson. The second portion of this lesson was to be the Time Management Module. Given that these modules underwent separate formative and summative evaluations, they will be described separately.

2.2.1 Orientation to CMI Module. The major design goals for this module were to (a) improve students' attitudes toward CMI and (b) reduce course completion time. It was hypothesized that if students were given a solid understanding of novel CMI features and instructional procedures, they would have a better appreciation for the benefits of this instructional system and would waste less time trying to figure the system out for themselves. It was also felt that students would begin using the CMI-provided instructional tools earlier in the course and would, accordingly, spend more time learning the instructional materials. A subordinate goal for this module was to provide students with appropriate role models for increasing acceptance of their responsibility for learning in a CMI environment.

2.2.1.1 Module Objectives. The stated objectives, listed in the front of the module were as follows: (a) You (the student) will be able to recognize the major differences between a computer-managed instructional system and a group-paced (conventional) instructional system; (b) You will be able to recognize those benefits and features of a computer-managed instructional system that help you to be responsible for what you learn; (c) You will be able to recognize how an efficient student is different from an inefficient student in a computer-managed instructional

TABLE 1

Student Opinions of a CMI Environment

QUESTIONS	STUDENT RESPONSES
1. What do you think about AIS?	All students interviewed liked AIS.
2. How do you like the idea of self-pacing?	IM-G, MF-G & MF-P liked self-pacing.[a] IM-P students preferred group-pacing.[a]
3. Do you have a feeling for how you are progressing?	Most students had devised some method of measuring their progress such as competing with peers, counting number of lessons done compared with those remaining, and/or calculating how much they had learned.
4. Do you think anyone cares about how you are doing?	Most students believed their instructors cared about how they were doing.
5. What strategies do you use to plan your time? Is it easy or difficult to plan time?	IM-G students generally used some time management strategies. About half of the IM-P students planned their time. None of the MF-G or MF-P students planned their time.
6. Do students care about doing well?	A majority of all students believed that other students wanted to do well in the course.
7. If you wanted to do better, what would you do?	A majority of all students indicated that they would "take more time."
8. What is the biggest problem students have with this course?	"Motivation" was mentioned by all students, although other problems such as reading comprehension and technical difficulty were also mentioned.

[a] IM-G = IM Course Good.
IM-P = IM Course Poor.
MF-G = MF Course Good.
MF-P = MF Course Poor.

TABLE 1 (Cont'd.)

QUESTIONS	STUDENT RESPONSES
9. If you were advising a student just starting this course, what would you tell him/her to do or not do?	The majority of all students indicated they would suggest that new students "ask questions." "Good" students suggested that new students not listen to the rumors about how easy/difficult specific sections of the course were. "Poor" students suggested that new students take notes.
10. If you were in charge of this course, what changes would you make?	Students from each sub-group mentioned giving students an option of group-paced or self-paced instruction. Poor students expressed a desire for more introductory information.
11. How do you feel about having to reach performance objectives?	A majority of all students indicated that the standards were acceptable.
12. Was there a point in the course where you felt unmotivated or lost interest?	IM-G, IM-P all mentioned Block III.
13. How do you feel about the computer grading your tests and giving you the next assignment?	A majority of students liked the computer grading their tests and giving them the next assignment.
14. How do you feel about your instructors?	All students interviewed had very good comments about their instructors.
15. Tell me about your study habits?	Students in all sub-groups generally answered the embedded questions and took notes. Many IM-G, IM-P & MF-P students used the objectives to review for a test whereas none of the MF-G students used this method. IM-G IM-P & MF-P students, more often used the block review lesson than did MF-G students.

TABLE 1 (Cont'd.)

QUESTIONS	STUDENT RESPONSES
16. How do you use the objectives?	A majority of all students read the objectives and many of them used the objectives to review for a test.
17. What motivates you to complete the course?	IM-P and IM-G students were most often motivated by pride. MF-G and MF-P students were most often motivated by external motivators such as "honor graduate" or "military career." Poor students in both courses were motivated by the realization that they were going home upon completion of the course.
18. How would you feel about having a target date set for you?	A majority of students thought a target date would be a good motivational tool for students.

system; and (d) You will be able to identify good techniques for managing your time.

2.2.1.2 Instructional Strategies and Procedures. The module was designed to be sufficiently general so that it could be used in a variety of military CMI environments. It contained no references to the students' specific course or training base and attempted to explain only those system features felt to be generic to a majority of CMI systems. It was intended that the module could be appended to the front of nearly any military CMI training course with few, if any, changes.

The instructional technique used to convey a positive set for both the CMI environment and the new behaviors required in this environment was a light, humorous, and persuasive style. Cartoon figures of male and female trainees were used in depicting self-talk sequences of efficient and inefficient CMI students.

2.2.1.3 Module Format and Evaluation Instruments. The Orientation Module was entitled "How to be a Successful Student in a Computer-Managed Instructional (CMI) System, or Now You Are Responsible for What You Learn." The module was written in a narrative style with extensive use of cartoons and diagrams to avoid the appearance of a technical document and to provide for low density. Vocabulary and grammatical style was kept as simple as possible, and an 8 1/2" x 11" illustrated text format was used.

The module was divided into four sections, each corresponding to one of the four objectives. Section 1 compared a CMI system with a group-paced system; Section 2 described the skills required of students in a CMI system and the benefits of such a system; Section 3 described the typical behavior of efficient versus inefficient CMI students; and Section 4 presented a rationale for good time management techniques in a CMI environment.

The evaluation instruments consisted of a ten-item pre/post Attitude Toward CMI Questionnaire and a post lesson test covering the objectives of both the Orientation and Time Management Modules. The attitude questionnaire consisted of ten Likert scale items focusing on the student's opinion of CMI. Item order was varied between the pre- and post-forms of the scale. A one-page, readministerable summary of the Orientation Module was also provided. This summary was designed to be posted in each learning center to remind students of appropriate behaviors in a CMI environment. Copies of all these materials can be found in AFHRL Technical Report No. AFHRL-TR-79-14.

2.2.2 Time Management Module. The major design goal for this module was reduction in course completion time beyond any reduction attributable to the AIS Student Progress Management Component (SPMC). Subordinate goals were that (a) students would maintain their individual progress tracking charts on a daily basis, (b) students and instructors would meet for scheduled Progress Counseling Sessions, and (c) students would express positive attitudes toward CMI in general and with the SPMC in particular.

2.2.2.1 Module Objectives. The module listed three objectives: (a) You (the student) will be able to use the computer to help you see how you are progressing toward your graduation day; (b) You will be able to keep track of your daily progress on a chart; and (c) You will be able to identify when to enter into a Progress Counseling Session with your instructor.

2.2.2.2 Instructional Strategies and Procedures. A progress charting technique constituted the primary strategy for promoting self-monitoring and self-management student behaviors in a CMI environment. This progress charting technique centered around a graph called a "Course Completion Map." The axes of the graph corresponded to the rate-of-progress information listed on the students' daily Student Status Report. The abscissa was labeled "Days Spent in Class," the ordinate was labeled "Days of Course Completed," and the divisions of the graph were in fifths of days. The student's Target Rate was shown as a 45-degree angle line extending from the origin out to the number of days targeted for course completion. The Map also contained a box wherein the student was to record the number of days he or she was targeted to spend in each block of the course (see Figure 1). The reverse side of the Course Completion Map contained instructions and a check list for Progress Counseling Session procedures (see Figure 2). Thus, this "Course Completion Map" was used in conjunction with progress feedback

FIGURE 1
COURSE COMPLETION MAP

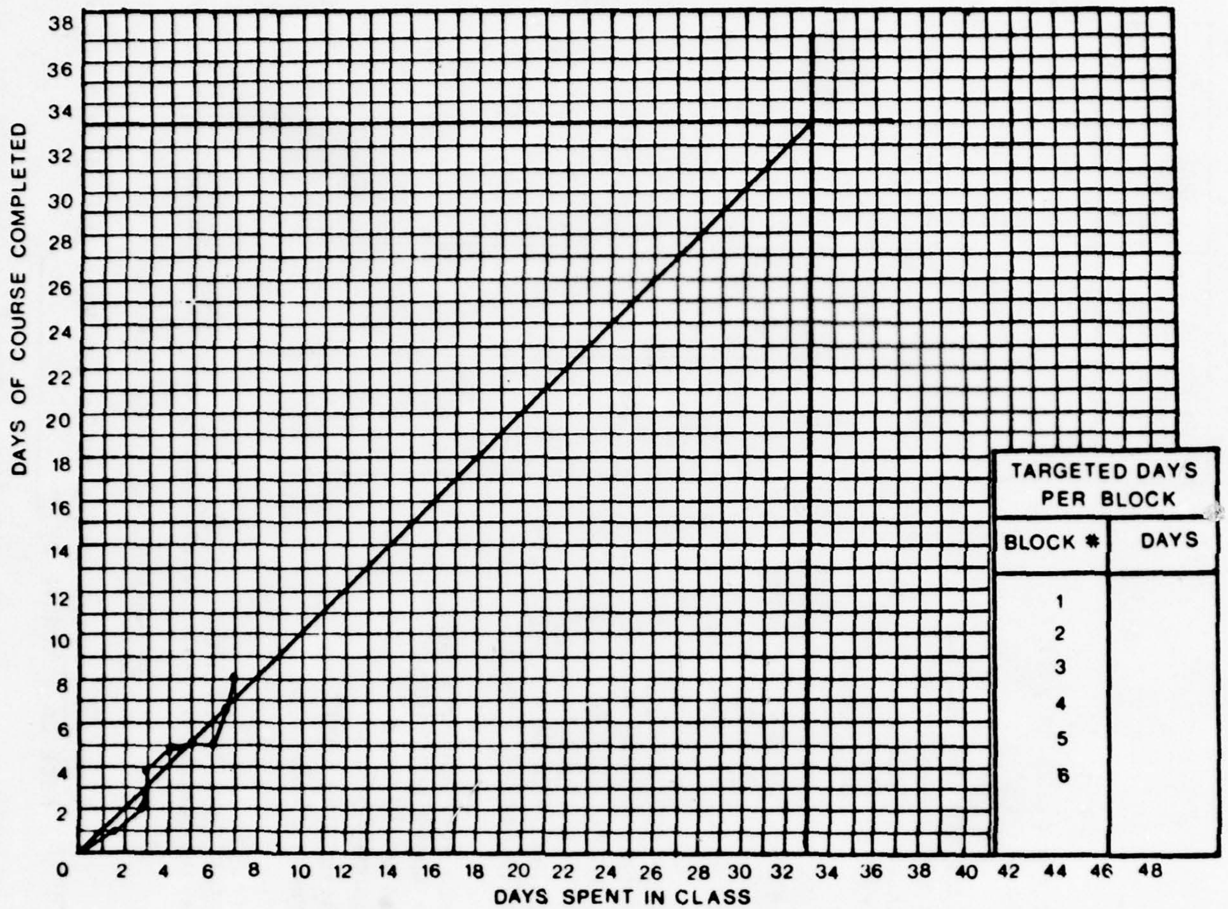

FIGURE 2

Progress Counseling Session Procedures

	BLOCK 2 CHECKPOINT		GRAD. DATE CHECKPOINT	
	YES	NO	YES	NO
1. Are you close to your Target Rate?				
2. If you are behind, do you see a way to get back on schedule fairly easily?				
3. If you are right on schedule, do you think you can improve your pace?				
4. If you are ahead of the Target Rate do you think you can continue at this pace and finish a little early?				
5. Given your answers to the above questions, what would be a reasonable but challenging goal? (Grad. date?)				

NOW GO SEE YOUR INSTRUCTOR
****

PERFORMANCE CONTRACT RECORD

Date _____: I am _____ days behind my Target Rate and agree to be back on schedule by ________________.

Date _____: I am _____ days behind my Target Rate and agree to be back on schedule by ___________________.

Date _____: I am _____ days behind my Target Rate and agree to be back on schedule by ___________________.

information provided by the SPMC to promote maintenance of students' time management skills.

Four new learning center procedures were also created for use in conjunction with the Time Management Module. First, instructors were required to periodically check their learning center roster to determine which students were either 2 days ahead or behind schedule and then to initiate Progress Counseling Sessions with these individuals. The instructor was to assist fast students by helping them to establish a Goal Rate indicating their personal goal for completing the course. To assist slow students, the instructor could initiate a "Performance Contract," an agreement between the student and instructor indicating that the student agreed to make up a specified number of days by a certain date.

The instructor could also change student target rates felt to be inappropriate, as described in Section 1.3.3 of this report. In order to monitor the frequency and direction of the target changes, instructors were directed to contact the contractor to initiate target changes.

The third new learning center procedure involved the documentation of Progress Counseling Sessions on a designated military form. This not only insured consistency when new instructors came into the learning center, but it also provided a method for determining the extent to which the procedures were being implemented.

The fourth procedure required instructors to periodically check students' Course Completion Maps to insure that they were accurately completed.

2.2.2.3 Module Format and Evaluation Instruments. The Time Management Module was entitled "Time Management in a Computer-Managed, Individualized Course, or If You Don't Know Where You Are Going, How Will You Know When You Get There." Like the Orientation Module, the Time Management Module was written in a light narrative style with vocabulary and grammar kept as simple as possible. Explicit directions and examples were provided for the performance portions of the instruction (i.e., creating the Course Completion Map) and cartoon graphics and diagrams were employed extensively. The module was bound in an 8 1/2" x 11" illustrated text format.

Major concepts to be covered in the module narration were (a) the importance of completing the course quickly via utilization of efficient time management skills, (b) why and how each student is given a specific number of days to complete the course based on the student's potential, (c) how students should manage their study time using the Progress Charting technique, and (d) how to schedule Progress Counseling Sessions.

The evaluation instruments for this module included the previously mentioned post-lesson test and five open-ended attitude questions deal-

ing with the student's opinion of the Time Management concept. Students were also given a Time Sheet which listed the average time-to-complete each lesson of the course. A one-page summary of the Time Management Module was printed on the reverse side of this handout. Copies of these instruments can be found in AFHRL Technical Report AFHRL-TR-79-14.

2.3 Formative Evaluation

Formative evaluation activities for both the Orientation and Time Management Modules were conducted in two Phases: (a) a small group tryout in which the module was administered to students and instructors to determine whether or not the module accurately and efficiently conveyed the desired information; and (b) an operational tryout in which the module was placed in the appropriate position in the course hierarchy and administered to students who met the criteria for being assigned that particular module, in order to assess the effects of the module on student performance and attitudes. Although appropriate revisions were made following each phase, the operational tryouts were essentially a form of summative evaluation.

The procedures and results of the formative evaluation for these two modules are extensively described in AFHRL Technical Report No. AFHRL-TR-79-14. For that reason, the following sections will briefly summarize evaluation results and changes made to the modules based on these results.

2.3.1 *Orientation to CMI Module.* In the interest of efficiency, small group tryouts for the Orientation Module and analysis of student study skill problems were conducted simultaneously via student and instructor interviews. A description of these interview procedures and types of interviewees can be found in Section 3.1 of this report. In general, 28 students from four student groups in the IM and MF courses were interviewed, along with 12 instructional staff members, and two student eliminees.

Pertinent small group tryout results included (1) mean time to complete the module was approximately 20 minutes, with a range of 16.1 to 23.5 minutes, (b) students expressed a need for embedded questions in the module, (c) students and instructors requested changes to several of the cartoons, and (d) a number of explanations of efficient student behaviors for CMI were in need of clarification. Based on these results, appropriate revisions to the Orientation Module were made prior to operational tryouts.

The opportunity for operational tryout of the Orientation to CMI Module materials was restricted to the Precision Measuring Equipment (PME) course since operational evaluations of the Study Skills Modules were scheduled concurrently in the other three AIS courses. For approximately 6 weeks, data were collected on block completion times and scores and pre/post Attitude Toward CMI scores, using data from

students who entered and completed the second CMI block in the course during this period. To provide an evaluation of the relative effectiveness of an Orientation versus No-Orientation condition, students were randomly assigned to Module 01 or 02, respectively, for this first lesson of the block.

At the completion of the evaluation period, data extracted for the criterion variables of interest revealed only nine cases for Module 01 and seven cases for Module 02. When time constraints were applied to exclude unreasonable cases (excessive block completion times), the number of cases for Module 01 dropped to four and the number of cases for Module 02 dropped to six. Analyses on both the constrained and unconstrained data revealed no reliable differences between the groups on block times, block scores, or attitude measures. The results of the operational tryout, although somewhat inconclusive due to the small number of students available for this evaluation, are promising in light of anecdotal data supplied by both students and instructors. That is, comments concerning this module indicated that (a) there was a definite requirement for orienting students to the novel aspects of a CMI environment and (b) the module designed was positively received. Thus, the final characteristics of the Orientation to CMI Module are those described in AFHRL Tecnhical Report No. AFHRL-TR-79-14.

2.3.2 Time Management Module. During small group tryouts of this module, a total of 42 IM students were administered the module on a one-to-one basis. In addition to observing problems and soliciting comments while students were working on the module, the evaluator administered the criterion test and five-item attitude questionnaire.

Results of relevance from the small group tryouts were that (a) although students received satisfactory criterion test scores and were able to initiate a Course Completion Map, they often had difficulty plotting their daily progress; (b) students expressed positive attitudes toward the module and that they thought it would benefit them; and (c) following the addition of two frames to the module which more thoroughly covered the daily plotting of progress, the mean time for 27 of the original 42 students to complete the module was 57.1 minutes. Module performance was considered satisfactory at this point, and ready for an operational tryout.

Operational tryout of the Time Management Module was conducted in the IM course, during which time it was installed as the first lesson in the first block of a special formative evaluation version of the course. The module questionnaire was not administered since a standard Student Attitude Questionnaire was administered at the end of Block 1. During the operational tryout period, 64 students entered the evaluation version of the course and of these, 28 completed the first four blocks. The number completing the remaining two blocks was too small for meaningful analysis.

Operational tryout results indicated that (a) first attempt module criterion test scores had a mean of 88.3, with only one student failing to meet the criterion of 60 percent, (b) first attempt lesson times were found to be unreliable due to the lesson's position as the first assignment in the course, against which administrative activities required at course entry were being charged, (c) students maintained their Maps with little difficulty and many indicated that they enjoyed keeping track of their daily progress, (d) comparisons of completion times and block scores for the first four blocks with a comparable group of students entering the course during the same period yielded no significant differences, but were considered promising in that evaluation students completed in 3.75 hours less than control students, and (e) evaluation students had less favorable attitudes than control students on items related to time management, i.e., they felt more pressure to complete the course quickly, felt less able to work at their own pace, and perceived their interactions with instructors to be less satisfactory than did control students.

Interviews with 13 evaluation group students were also conducted as part of the operational tryout. From these interviews it was learned that many of the students did not understand the concept of completing the course as quickly as possible with minimal passing grades, and when it was explained to them, they expressed that they did not like this compromise. These results, along with other tryout results led to a number of revisions to the Time Management Module. These included (a) a more indepth explanation of the differences between the goals of military technical training and public school education, (b) adding a handout listing average completion times for each lesson in the course to help students pace themselves on a lesson-by-lesson basis, and (c) including summarized directions for plotting daily progress, scheduling Progress Counseling Sessions, and defining a "Goal Line." The lesson test criterion was raised to 70 percent and a second parallel version was created.

2.4 Summative Evaluation

For the purposes of this project, summative evaluation was considered to be a second large-scale tryout in which data on approximately 50 students per treatment were collected. Given time and resource constraints, it was necessary to restrict full summative evaluation of only the Time Management Module portion of the total Orientation Lesson.

2.4.1 Time Management Module. Summative evaluation of the Time Management Module was conducted in two phases. During Phase I, the AIS was undergoing an extensive evaluation (Integrated System Test) and the utility of the Student Progress Management Component (SPMC) was a major consideration in this evaluation. The Time Management Module had come to be considered an integral part of the SPMC and, thus, Phase I of the evaluation addressed the combined effects of SPMC and the Time Management Module. Following completion of the Integrated System Test, Phase

II of the evaluation addressed the effects of the Time Management Module *per se* in the presence of the SPMC.

2.4.1.1 Phase I Evaluation Procedures and Results. During the Integrated System Test, students entering the IM course were randomly assigned to one of three versions of the course: a "Main Track" version in which all students were assigned the instructional mode originally developed for that lesson; an "Individualized Instructional Assignment" version, in which students were assigned one of two to five alternate instructional modules on the basis of their predicted time and score under each alternative treatment; and a "Random" version in which students were randomly assigned one of the alternative modules. Since Main Track and Individualized Instructional Assignment were considered representative of two modes in which CMI might be used for military technical training, a question of interest was whether students would react differently to the SPMC and the Time Management Module under these two conditions.

The SPMC and the Time Management Module were introduced halfway through the Integrated System Test. The "no progress management" period lasted a total of 57 class days. A comparable 57 class day period was defined beginning with the implementation of the SPMC (and Time Management Module). Students who began the course and completed one or more blocks in the Main Track or Individualized Instructional Assignment versions during the no-management and management periods constituted the control and evaluation groups, respectively. During the management period, the Management Component Policy Function was set to 90 percent.

2.4.1.1.1 Module Performance Data. The Time Management Module was moved to the second lesson in the first block to avoid contamination of the lesson timing data. After about a month, however, course management moved the first two lessons out of the first block and administered them as part of the preassessment activities. Consequently, collection of module performance data was restricted to the first 20 class days of the evaluation period.

Mean first-attempt lesson time (based on the data of 106 students) was 87.6 minutes with a standard deviation of 21.6 minutes.

For 126 students with item level criterion test data, the Alpha reliability of the test was found to be only .440 due primarily to six test items. Five of these six items had very low error rates and the sixth (pertaining to the frequency with which rate of progress data is provided) had a high (45 percent) error rate. These items were subsequently revised and satisfactory reliability was found for both forms of the test.

First-attempt criterion test scores were available for 136 of the evaluation group students who completed the first block of the course. For those students, the mean first-attempt score was 86.5. Nine students

(6.6 percent) failed to meet the criterion of 70 percent correct.

2.4.1.1.2 Block Completion Time and Score Data. The question of primary interest concerned the hypothesized reduction in block and course completion times under Student Progress Management. Of secondary interest was whether students would react differently to Progress Management under Main Track versus Individualized Instructional Assignment. The block time data (block elapsed time less absence time), a measure of total course (cumulative times over six blocks for students having reliable data for all six blocks), and first attempt block test scores were, therefore, evaluated by means of two-by-two analyses of variance. The F tests of interest in these analyses were the main effects for Management/No-Management and the interaction between Management/No-Management and assignment mode. Main effects for assignment were not of interest for this evaluation.[1]

None of the seven time comparisons or six score comparisons indicated a significant interaction between Management/No Management and assignment mode. All of the seven time comparisons and four of the six score comparisons did, however, indicate significant ($p < .01$) main effects for Management/No Management. It was concluded that the effects of Student Progress Management were not moderated by the two differing modes of assignment. Consequently, the data obtained under the two assignment modes were combined and only the main effect of Student Progress Management will be discussed. The means and standard deviations of the block times and scores obtained under Progress Management (Evaluation Group) and prior to implementation of the Progress Management Component (Control Group) are presented in Table 2, along with the time and score differences between the two groups and the percentage time changes.

As Table 2 indicates, the mean completion time for Block 1 was 20.00 hours for the evaluation group as contrasted with a mean of 23.75 hours for the control group. This is a savings of 3.75 hours or 15.8 percent ($F(1,575) = 37.150$, and $p = .001$). This is not, however, a clean comparison because of the changing content of the block: addition of the Time Management Module at the start of the evaluation period and removal of both the module and the first lesson three weeks later.

The next two blocks, 2 and 3, both demonstrated significant time savings: 10.3 percent for Block 2 ($F(1,505) = 15.760$, $p = .001$); and 13.7 percent for Block 3 ($F(1,435) = 14.145$, $p = .001$).

While still significant, Progress Management had relatively little effect on Block 4 times, resulting in only a 6.6 percent reduction

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[1] An evaluation of the Individualized Instructional Assignment (as contrasted with Main Track) will be reported in McCombs et al. (Note 3). It should be noted that while only block level data are reported here, the questions of primary interest in the McCombs et al. evaluation involved lesson level data.

TABLE 2

BLOCK TIMES AND SCORES FOR
SUMMATIVE EVALUATION AND CONTROL GROUPS

VARIABLE	EVALUATION N	EVALUATION $\overline{X}$	EVALUATION SD	CONTROL N	CONTROL $\overline{X}$	CONTROL SD	EVALUATION - CONTROL	PERCENTAGE CHANGE
Block 1 Time[a]	300	20.00	6.93	276	23.75	8.12	- 3.75	-15.8
Block 2 Time	274	26.05	7.62	233	29.03	9.03	- 2.98	-10.3
Block 3 Time	246	34.10	9.55	190	39.50	11.68	- 5.40	-13.7
Block 4 Time	243	21.08	5.37	180	22.58	6.42	- 1.50	- 6.6
Block 5 Time	197	23.15	5.52	152	25.88	8.12	- 2.73	-10.5
Block 6 Time	196	16.23	4.32	174	18.92	3.63	- 2.69	-14.2
Total Time, Blocks 1-6	75	136.13	31.33	115	153.33	31.52	-17.20	-11.2
Block 1 Score[b]	359	80.3	10.8	280	82.5	10.3	- 2.2	
Block 2 Score	320	79.8	12.8	251	82.3	11.8	- 2.5	
Block 3 Score	304	74.1	11.3	208	77.6	10.2	- 3.5	
Block 4 Score	269	81.1	9.7	192	83.4	9.1	- 2.3	
Block 5 Score	233	76.7	14.6	163	80.9	10.1	- 4.2	
Block 6 Score	223	82.7	10.7	155	84.8	9.9	- 2.1	

a. Times shown in hours.
b. Scores shown as percentages.

TABLE 3

PERCENTAGES OF FIRST ATTEMPT BLOCK FAILURES FOR
SUMMATIVE EVALUATION AND CONTROL GROUPS

Block	Evaluation N	Evaluation Percentage Failures	Control N	Control Percentage Failures	Evaluation - Control Percentage Failures	Chi-Square	P
Block 1	375	16.0	293	8.9	7.1	7.436	.01
Block 2	329	14.9	261	11.9	3.0	1.132	.30
Block 3	302	29.1	216	19.4	9.7	6.283	.02
Block 4	231	12.5	199	8.0	4.5	2.353	.20
Block 5	244	22.5	170	18.8	3.7	0.823	.50
Block 6	232	7.8	166	4.8	3.0	1.329	.30

($F(1,422) = 6.992$, $p = .008$). While there is no obvious reason why Block 4 should be less susceptible to Progress Management, it may be that the "mid-course slump" was relatively impervious to the treatment.

The final two blocks, 5 and 6, had a pattern similar to the first three blocks: a 10.5 percent reduction in Block 5 ($F(1,348) = 13.776$, $p = .001$); and a 14.2 percent reduction in Block 6 ($F(1,342) = 29.019$, $p = .001$).

For comparing total course completion times, only data from evaluation or control group students who completed all six blocks with reliable times were considered. A prolonged computer failure during the evaluation period rendered many of the evaluation group students' times unreliable and substantially reduced the available n. For the remaining 75 evaluation group students, the mean course completion time was 136.13 hours (22.69 six-hour days), a reduction of 17.20 hours (2.86 days) from the control group mean, an overall reduction of 11.2 percent ($F(1,139) = 13.445$, $p = .001$).

A reasonable question is the extent to which block time reductions were attributable to increased homework. The percentage of lessons marked as homework actually declined from 8.57 percent for the control group to 4.00 percent for the evaluation group. Although at least part of this apparent reduction may have been due to changes in homework reporting procedures, there is no evidence that the block time reductions can be attributed to increased homework. Thus, the major factor contributing to the time reductions would appear to be increased student productivity during the normal shift.

Implementation of Student Progress Management was found to have a negative effect on first-attempt end-of-block test scores. As shown in Table 2, the evaluation group's scores tended to be two to four percentage points lower than those of the control group. F tests of the score differences between groups indicated that only the Block 2 difference failed to at least approach significance at the .01 level.

It can be argued that, in a criterion-referenced testing environment, a reduction in mean block scores is not necessarily undesirable if the test failure rate is not increased. The number of first-attempt block test failures in the evaluation and control groups were contrasted by chi-square tests. The percentage of failures, by block, in each group, the chi-square values, and the resultant significance levels are shown in Table 3. Although the percentage of failures was consistently higher under the evaluation condition, the differences were statistically significant ($p < .05$) in only two of the six blocks: Blocks 1 and 3. It should be noted, however, that the total time students spent in a block, including any time spent in remediation following a block test failure was, on the average, less than the time to complete the block prior to implementation of Progress Management.

2.4.1.1.3 Student Attitude Questionnaire Data. The same eight Student Attitude Questionnaire items used in formative evaluation were employed to evaluate attitude differences between the control and evaluation groups. In this case, data were available from both administrations of the questionnaire: following Block 1 and at the end of the course, following Block 6. Item responses are arranged in a five point scale ranging from "Strongly Disagree" to "Strongly Agree" and are scored such that the most positive response is given a weight of five and the most negative a weight of one. The items, median responses from both administrations, differences between the evaluation and control group medians, the chi-square values ($df = 4$), and the chi-square probability levels (if $p < .10$) are presented in Table 4.

The first three items pertain to students' perceptions of their pace through the first block (first administration) or the course (second administration). The evaluation group's pattern of responses to the first item, were significantly more negative than those of the control

TABLE 4

ATTITUDE QUESTIONNAIRE RESPONSES FOR SUMMATIVE EVALUATION AND CONTROL GROUPS

Attitude Items	Block	Evaluation N	Evaluation Mdn.	Control N	Control Mdn.	Evaluation - Control Mdn.	Chi Square	P
I felt that I could work at my own pace.	1	353	4.32	274	4.55	-.23	12.468	.014
	6	212	4.49	158	4.46	.03	3.540	
Since Denver is such a nice area, I was not in a hurry to finish the course.	1	354	4.15	275	3.99	.16	5.017	
	6	213	4.03	160	3.93	.10	2.006	
I saw no reason to hurry through the course.	1	347	3.83	273	3.28	.55	28.761	.001
	6	210	3.67	157	3.37	.30	8.857	.065
I found myself trying to get through the programmed texts rather than trying to learn.	1	354	3.77	275	3.85	-.08	3.295	
	6	210	3.52	158	3.80	-.28	7.300	
I am anxious to get to my first assignment after finishing Tech school.	1	356	4.81	279	4.74	.07	4.414	
	6	211	4.63	159	4.53	.10	5.477	
The instructors helped me and encouraged me to do well.	1	349	4.22	275	4.11	.11	7.114	
	6	207	4.38	160	4.33	.05	1.705	
I felt that I was not given enough personal attention.	1	351	4.30	272	4.18	.12	11.921	.018
	6	214	4.17	156	4.12	.05	2.268	
I felt no one really cared whether I worked or not.	1	355	4.27	277	4.17	.10	6.719	
	6	213	4.35	158	4.21	.14	10.388	.034

group at the end of Block 1, but the responses of the two groups were essentially equivalent at the end of the course. Whereas the median response of the control group declined over time, the evaluation group's median response increased as students gained experience with Progress Management. The evaluation group's responses to the remaining two items are all slightly more favorable than those of the control group but only one comparison was statistically significant.

The next two items, pertaining to students' perceptions of the instructional methods and the career field, did not differentiate between groups.

The final three items pertain to students' perceptions of their interactions with their instructors. In contrast to the formative evaluation, all three items demonstrated a slight positive shift, significant at the .05 level in two of the six comparisons.

2.4.1.1.4 Revisions to the Criterion Test. Based on Phase I results, two items having very low error rates were eliminated since they tested concepts covered by other items. Distractors were reworded for the remaining three items. The high error rate item, pertaining to the frequency with which rate of progress data is provided to the student, was also eliminated since students quickly learn this information in the first few days of the course. Corresponding changes were made to the second form of the test and both forms were implemented with a more stringent passing criterion of 80 percent correct.

2.4.1.2 Phase II Evaluation Procedures and Results. In the second Phase of summative evaluation, the effect of the Time Management Module *per se* was evaluated in the Inventory Management course. Two versions of the course were defined: an evaluation version, containing the Time Management Module as the student's first assignment after entering the learning center; and a control version in which students were given a placebo handout explaining the operation of the SPMC. Student Progress Management and Individualized Instructional Assignment were in operation in both versions of the course. Course completion times had become somewhat shorter and the Policy Function was raised to 95 percent.

The evaluation and control versions of the course were each taught in two learning centers on each of two shifts. While random assignment of students to versions within learning centers would have been a preferable experimental design, it was thought that the continuing visible effects of the Course Completion Map would contaminate the control group. At the start of the evaluation period, all entering students were assigned to one of the two versions. It was intended that this procedure would continue for at least 2 months.

Intervening events, however, prevented completion of the full evaluation plan. First, it was determined that instructors in one of the

evaluation group learning centers had misunderstood the procedures and had instructed students to skip the Time Management Module and continue with their normal course work. These students were eliminated from the evaluation. To compensate for the reduced $\underline{n}$, the proportion of incoming students assigned to the evaluation group was raised to 65 percent.

It was then learned that the AIS was to be submitted to a second evaluation (Service Test) in which the second shift would be run without computer support. The Service Test Plan went into effect on the twentieth class day of the evaluation period, preventing further data collection for second shift students. Since very little data were available in the latter half of the course, data collection was continued one more week for those first shift students who had entered the course prior to the Service Test.

2.4.1.2.1 Module Performance Data. Reliable lesson times were available for only 68 of the students who completed the first block of instruction. For these students, the mean first-attempt lesson time was 97.0 minutes (standard deviation of 31.9 minutes).

Reliable, item-level criterion test data were available for 82 evaluation group students: 44 on Form 1 of the test and 38 on Form 2. The Alpha reliability of Form 1 was .883 while Form 2 registered an Alpha of .903. This increased reliability was, however, obtained at the cost of increased difficulty. The mean percentages correct for the two forms were 74.5 and 68.8, respectively. Further investigation revealed that these low means were largely attributable to the two performance items not being marked by the instructors for almost half of the students. If these missing scores had been present, the means for the two forms would have been 80.9 and 75.1 percent, respectively. Form 2 of the test was slightly more difficult. Given the test criterion of 80 percent correct, the first attempt failure rate would have been quite high even if the missing performance items had been marked.

2.4.1.2.2 Block Completion Time and Score Data. A total of 79 evaluation and 79 control group students began and completed the first block of the course during the evaluation period. The number completing each successive block declined, with only 16 evaluation and 28 control group students completing the full six blocks of the course. Students who completed the latter blocks tended, of course, to be faster workers, regardless of treatment group.

Students were found to be unevenly balanced across the evaluation and control groups with respect to predicted course completion times. While this suggested analysis of covariance, a question of interest concerned whether the presence of the Time Management Module had differential effects on the rates of students predicted to have fast course completion times as compared with those predicted to complete the course more slowly. That is, was there an interaction between predicted course completion time and the presence/absence of the module? To test

for such interactions, a pair of linear models (Ward & Jennings, 1973) was defined for each block in which the criterion variable was block completion time (block elapsed time less absence time). The first predictor variable was predicted course completion time, and the second predictor variable was a binary vector representing the presence or absence of the Time Management Module. For the "full" models, both the intercepts and slopes of the two regression lines (representing the evaluation and control groups) were allowed to vary between groups while, in the restricted models, only the intercepts were allowed to vary. Comparisons of the error sums of squares of the two types of models, by means of an F test, is a test for homogeneity of regression. That is, a significant F would indicate that the slopes of the two regression lines were not parallel.

No significant ($p < .05$) interactions were found for any of the six blocks. In fact, five of the six F values obtained were less than 1.0. Since the assumption of homogeneity of regression was met, analysis of covariance was employed to evaluate the effect of the Time Management Module on block completion times and scores.

The means and standard deviations of the evaluation and control group block completion times (adjusted for differences in the covariable of predicted course completion time) and the raw and percentage differences between groups are shown in Table 5. Since so few students completed the full course during the evaluation period, cumulative times are also shown for students completing the third, fourth, fifth, and sixth blocks.

As shown in Table 5, reliable Block 1 completion times were available for 77 evaluation group students and 76 control group students. The adjusted mean block time for the evaluation group was 19.51 hours, not significantly different from the mean (19.54 hours) of the control group. This indicates that evaluation group students had regained the time required for the Time Management Module itself by the end of the first block.

For Blocks 2 and 3, the mean block completion times of the evaluation group were approximately nine percent shorter than those of the control group and both comparisons approached significance at the .05 level: Block 2 ($F(1,122) = 3.864$, $p = .052$); Block 3 ($F(1,98) = 3.483$, $p = .065$). The fact that these relatively large differences failed to achieve significance was due primarily to the high variability of the block completion times.

The Block 4 and 5 comparisons indicate even larger time savings, almost 15 percent, attributable to the Time Management Module, both of which achieved significance: Block 4 ($F(1,73) = 6.079$, $p = .016$); Block 5 ($F(1,53) = 4.490$, $p = .039$).

The apparent time savings attirubtable to the module in the sixth

TABLE 5

BLOCK TIMES FOR PHASE II
SUMMATIVE EVALUATION AND CONTROL GROUPS

VARIABLE	EVALUATION N	EVALUATION $\overline{X}$	EVALUATION SD	CONTROL N	CONTROL $\overline{X}$	CONTROL SD	EVALUATION - CONTROL	PERCENT AGE CHANGE
Block 1 Time[a]	77	19.51	6.23	76	19.54	6.29	- 0.03	- 0.15
Block 2 Time	59	23.77	7.52	66	26.10	7.93	- 2.33	- 8.93
Block 3 Time	39	32.11	10.26	62	35.39	11.01	- 3.28	- 9.27
Block 4 Time	28	18.45	5.76	48	21.70	5.64	- 3.25	-14.98
Block 5 Time	20	19.01	5.91	36	22.36	5.96	- 3.35	-14.98
Block 6 Time	16	11.75	2.63	27	15.12	4.72	- 3.37	-22.29
Total Time, Blocks 1-3	34	74.11	23.13	53	78.26	21.77	- 4.15	- 5.30
Blocks 1-4	21	86.10	24.64	38	95.54	25.23	- 9.44	- 9.88
Blocks 1-5	13	95.19	26.69	25	108.94	25.52	-13.75	-12.62
Blocks 1-6	10	101.22	18.23	19	118.76	23.64	-17.54	-14.77

a. Times, in hours, adjusted for differences in predicted course completion time.

block exceeded 20 percent but the number of students completing this block with reliable times was so small as to make the comparison suspect. Despite the small $\underline{n}$, the difference between the adjusted means was significant ($F = 6.674$, $df = 1/40$, $p = .014$).

Since the Phase I and II evaluation groups both received the same treatment, one might expect the block times to be similar while, in fact, the Phase II evaluation group times were consistently shorter. Two factors contributed to this difference: Course completion times tended to become shorter during the period between the two comparisons, and since the Phase II evaluation period was only half as long as the Phase

I period, data in the later blocks of the Phase II comparison tended to be from faster students.

Cumulative times were obtained for those students who had reliable block completion times on the first through third, fourth, fifth, and sixth blocks. These values, adjusted for differences in the covariable, are shown in the lower half of Table 5. Thirty-four evaluation and 53 control group students completed the first three blocks with reliable times on all three blocks. The mean of the evaluation group was 4.15 hours less than that of the control group, a difference which was not statistically significant. By the end of the fifth block, the number of students having become quite small, the 13.75 hour savings did at least approach significance ($F(1,35) = 3.954$, $p = .055$). Finally, for those students with reliable times on all six blocks, the apparent advantage for the evaluation group was 17.54 hours ($F(1,26) = 5.431$, $p = .028$). Despite the several comparisons which failed to achieve statistical significance, the consistency with which the control group means exceeded those of the evaluation group strongly suggests that the Time Management Module did indeed have the effect of decreasing block completion times.

The means and standard deviations of the six block test scores, adjusted for differences in the covariable, are presented in Table 6. As is shown by the right-most column, there was no consistent pattern of differences between the two groups. Further, none of the differences were statistically significant as evaluated by analysis of covariance. The number of first-attempt evaluation and control group block test failures were also compared by means of Chi Square tests. None of the six comparisons approached statistical significance. It can be concluded that the time savings attributable to the Time Management Module were not achieved at the cost of increased block test failures.

A comparison of the score means shown in Table 6 with those obtained during the Phase I evaluation suggests that the negative effects observed when Student Progress Management was first implemented were only temporary. The across-block, unweighted mean score of the Phase I control group was 81.92 while that of the Phase I evaluation group was 79.12. The unweighted mean of the Phase II evaluation group, 81.95, returned to the level observed prior to implementation of Progress Management.

2.4.1.2.3 Student Attitude Questionnaire Data. The same eight Student Student Attitude Questionnaire items (see Table 4) were again employed to evaluate differences in attitudes attributable to the Time Management Module. For the first three items, pertaining to students perceptions of their pace through the course, only one of the six chi-square comparisons indicated a significant difference ($p = .037$) between the responses (on a 5-point, bipolar scale) of the evaluation and control group. Evaluation group students more strongly disagreed with the statement "since Denver was such a nice area, I was not in any hurry to finish the course," than did control group students but only on the first

TABLE 6

END-OF-BLOCK TEST SCORES FOR PHASE II SUMMATIVE EVALUATION AND CONTROL GROUPS

VARIABLE	EVALUATION N	EVALUATION $\overline{X}$	EVALUATION SD	CONTROL N	CONTROL $\overline{X}$	CONTROL SD	EVALUATION - CONTROL
Block 1 Score[a]	79	82.7	9.72	81	81.3	10.58	+ 1.4
Block 2 Score	63	81.3	13.29	79	81.3	11.47	0.0
Block 3 Score	43	80.0	9.83	64	76.9	10.70	+ 3.1
Block 4 Score	31	82.5	9.12	51	82.6	10.41	- 0.1
Block 5 Score	22	81.1	10.85	39	81.7	10.64	- 0.6
Block 6 Score	16	84.1	8.46	28	85.4	8.20	- 1.3

a. Scores, shown as percentages, adjusted for differences in predicted course completion times.

(Block 1) administration of the scale. The effects of the Time Management Module in this area were apparently only slight and diminished over time.

The only other item which approached significance ($p = .060$) was for the end-of-course administration of the statement "the instructors helped me and encouraged me to do well," on which the responses of the evaluation group were more positive than those of the control.

Soon after the Progress Management Component had been implemented, 20 items were added to the Attitude Questionnaire dealing specifically with Student Progress Management. A comparison of the evaluation and control group responses to these items indicated that of the 40 chi-square comparisons only two (the number to be expected by chance) registered significant differences at the .05 level. Evaluation group students more strongly agreed with the statement "it was difficult concentrating when I knew I was behind (target)," than did control group students on both the Block 1 and end-of-course administrations of the questionnaire. This result could be interpreted as either (a) the Time Management Module Course Completion Map may have increased students' anxiety when they were behind target or (b) the control group students attached little importance to the target rate.

3.0 STUDY SKILLS TRAINING PACKAGE

3.1 Problem Definition

Following the development and implementation of the Orientation to CMI and Time Management Modules, it became apparent from instructor comments and observations that another area of student problems in the AIS environment was the lack of appropriate study skills. To further define specific skills deficiencies, a second series of interviews were conducted with personnel from the IM and MF courses. These interviews were conducted during the formative evaluation of the Orientation Module, and four categories of personnel were interviewed: current students, students eliminated from their course, course instructors, and course supervisors.

Current students interviewed were members of one of four subgroups: (a) Experienced-Good, (b) Experienced-Poor, (c) Naive-Good, and (d) Naive-Poor. Experienced students were those who had finished all but two blocks of their course, with good students being differentiated from poor on the basis of whether they were at least 2 days ahead of their Target Completion Date and had at least an 80% grade point average versus being 2 days or more behind their Target Completion Date and having a grade point average of less than 80%. Naive students were those who were still working in the first block of their course and were predicted to take less (good group) versus more (poor group) than the mean completion time to finish the course. A total of seven students were interviewed in each of these four groups, as well as eight instructors, four supervisors, and two eliminees.

Each interview lasted approximately 60 minutes, with about one-fourth of this time being devoted to the interviewee reading the Orientation Module. In the "Pre-Module" section of the interview, nine questions concerning students' feelings about being back in school, their study habits and their experience with individualized instruction were used. The results of the student responses to these questions are summarized in Table 7 and the results of the instructor and supervisor responses are summarized in Table 8.

The following conclusions were drawn from these interviews.

1. Although most students like the idea of taking responsibility for their own learning, most are generally not prepared to handle the responsibilities of individualized instruction, according to their instructors; hence, there is a need for some type of remedial training in study skills and self-discipline.

2. Since staff personnel indicated that they spend a major portion of their time with students who are having difficulty with their courses, these personnel would be likely to benefit from some training in study skills remediation approaches and general diagnostic and counseling skills.

TABLE 7

Student Opinions of Their Study Skills

QUESTIONS	STUDENT RESPONSES
1. How do you feel about being back in school/about school in general?	Naive-Good students had the lowest opinion of school; Naive-Poor students had the highest opinion. Good students had a lower opinion of school than Poor students and Naive students had a slightly better opinion of school than Experienced students.
2. How would you rate your study skills?	A majority of both Good and Poor students rated their study skills as average. About one-fifth of both the Good students and the Poor students rated their study skills as good. Several of the Poor students, but none of the Good students, rated their study skills as poor.
3. Have you ever had an individualized course before this one, and if so, what was your opinion of this experience?	Four of the 14 Good students had previous experience with individualization, and one of the 14 Poor students had this type of experience. All of the students who reported prior individualization experience rated it positively.
4. How do you feel about taking responsibility for your own learning?	A majority of all students liked this feature, less than one fifth were ambivalent and none reported a dislike of this individualization characteristic.
[a]5. How would you feel if grades were eliminated and the course were merely pass/fail?	A majority of the Experienced-Poor students and all of the Experienced-Good students from the IM school indicated that they would dislike such a change, whereas both of the Experienced-Good students from the MF school thought they would like a pass/fail system.
[a]6. Do you plan your study time?	A majority of the Experienced-Good students reportedly planned their study time, whereas less than half of the Experienced-Poor did this.
[a]7. Do you use the objectives and the embedded questions?	All of the Experienced students indicated that they used the objectives and the embedded questions.
[a]8. Do you use them the way the text suggests?	Less than half of the Experienced-Good students and less than one-third of the Experienced-Poor students reportedly used the objectives and embedded questions in the manner suggested by the text.
[a]9. How do you feel about the method the text suggests?	A majority of all Experienced students liked the method the text suggested.

[a] Naive students were not asked questions 5 through 9.

TABLE 8

Staff Opinions of Student Study Skills

QUESTIONS	STAFF (INSTRUCTORS & SUPERVISORS) RESPONSES
1. How do students feel about being back in school?	A majority of the staff believed that students either liked being back in school or were ambivalent about this situation.
2. What kind of study habits do students have?	A majority of the staff indicated that most students have poor study habits.
3. About how many students have had experience with individualized instruction before coming to this course?	A majority of the staff indicated that, for most students, this CMI course is their first experience with individualized instruction.
4. How do students feel about taking responsibility for their own learning?	A majority of the staff stated that most students either do not know how or do not want to take responsibility for their own learning.
5. How would you feel if grades were eliminated and the course were merely pass/fail?	Slightly less than half the instructors felt that changing the course to a pass/fail system would be desirable. None of the supervisors agreed with this opinion although a majority of them were ambivalent on this subject. Slightly less than half the instructors felt that such a change would be undesirable.
6. Do students plan their study time?	Two-thirds of the instructors believed that students do not plan their study time, whereas a majority of the supervisors believed that students "sometimes" plan their study time.
7. Do students use the objectives and embedded questions?	A majority of the instructors thought that students "sometimes" use the objectives and the embedded questions. Supervisors were evenly divided between "usually" and "sometimes."
8. Do they use them the way the text suggests?	A majority of the instructors thought students "sometimes" used the objectives and embedded questions the way the text suggested, but supervisors were evenly divided between "sometimes" and "rarely."
9. How do you feel about the method the text suggests?	A majority of the staff liked the method suggested by the text for using objectives and embedded questions.

3. Since most students indicated that they did not dislike school, it is likely that providing them with specific study skills training would improve their performance in the course. Thus, the interviews indicated the need for both student study skills training and instructor training in the diagnosis and remediation of student study skills problems.

3.2 Module Design and Development

The detailed rationale and procedures used in the design and development of the Study Skills Package are presented in AFHRL-TR-79-43 That report also contains copies of the instructional materials and all evaluation instruments. Consequently, this section will provide only brief descriptions of the materials in the Study Skills Package (i.e., the four Study Skills Modules, the Study Skills Questionnaire, and the Instructor Orientation and Training Workshops).

3.2.1 Study Skills Modules. The student and instructor interview results indicated that many military trainees do not possess the study skills which are vital to success in a CMI environment. Furthermore, those trainees who do possess such skills seem to have difficulty transferring these capabilities from their prior lock-step experience to their present CMI experience. Hence, there appears to be a definite requirement for teaching students how to transfer appropriate learning strategies and skills from their past experiences to a new CMI environment and how to improve upon or add to their study skills repertoire.

It was hypothesized that a set of consumable modules (modules which students can keep) dealing with various study skills would be an appropriate solution to the foregoing problem. The decision to make the modules consumable was based on the idea that students often need to return to new material to freshen their memories and clarify confusing or difficult areas. In addition, since the use of good study skills is an on-going requirement in the course, it was judged desirable to give students a set of materials to which they could refer whenever it was necessary.

The major design goal of the Study Skills Modules was to provide poorly skilled students with appropriate skills for improving their performance in the course and reduce the amount of time required to complete. The four study skills areas which were isolated as being the most troublesome were (a) Reading Comprehension, (b) Memorization, (c) Test Taking, and (d) Concentration Management. A set of materials was written for each of these four areas and packaged individually, so that a student could receive any or all of the packages as deemed necessary by an instructor.

3.2.1.1 Module Objectives. The objectives for the Reading Com-

prehension module were as follows: (a) You (the student) will be able to use the Questionning method of studying; (b) You will be able to use the Network method of studying; (c) You will be able to use the Problem Solving method of studying; and (d) You will be able to determine which of these three reading methods is best for you and to use this method when you are studying.

The Memorization module had one objective: You (the student) will be able to increase your skills in memorizing information by using mnemonics such as elaboration, mental pictures and grouping.

The six objectives of the Test Taking module, entitled Test-Wiseness, were as follows: (a) You (the student) will be able to use methods for completing tests on time without giving up any accuracy; (b) You will be able to carefully read and understand test directions and test questions; (c) You will be able to use good methods for figuring out how and when to guess on test questions; (d) You will be able to use logical reasoning to answer test questions when you are not sure of the correct answer; (e) You will be able to understand that test anxiety is a habit, a hard-to-control feeling of fear of tests and thinking about tests; and (f) You will be able to use specific methods for controlling most of the test anxiety which you might have when you sit down to take a test.

The two objectives of the Concentration Management module were: (a) You (the student) will be able to identify the difference between good study moods and bad study moods, and (b) You will be able to use proper methods for changing your bad study moods into good study moods.

3.2.1.2 <u>Instructional Strategies and Procedures</u>. The primary instructional strategies incorporated into the four Study Skills Modules were active information processing techniques and positive self-talk behavioral control techniques. In the Reading Comprehension Module, the three recommended reading methods required students to not only become actively involved in the material, but to also make changes to that material so as to personalize it and integrate the information with existing cognitive structures. Similarly, the Memorization Module introduced the concept of mnemonics, or memory aids, as methods for personalizing information and making it more meaningful. Both the Test Taking Module and Concentration Management Module utilized the concept of appropriate self-talk as a method for reducing test anxiety, combatting boredom or anxiety when trying to study, and maintaining a good study mood.

3.2.1.3 <u>Module Format and Evaluation Instruments</u>. The four Study Skills Modules were written in the same narrative style as the previous two modules; however, the use of cartoons and diagrams was significantly reduced due to the length of each module. Each module was bound separately as a consumable 8 1/2 by 11 inch illustrated text.

The evaluation instruments for the Reading Comprehension Module included worksheets and practice exercises for the three reading methods introduced. The Memorization Module used examples and practice exercises for each of the three types of mnemonic techniques (elaboration, mental pictures, grouping). A 20-item self test, followed by a test key and descriptions of how students could have used the test-taking skills presented in the Test Taking Module to figure out the answer to the self-test questions if they had been unsure, was the evaluation instrument used in the Test Taking Module. Finally, the Concentration Management Module included several worksheets for students to use in recording what made them lose their concentration, how they felt about this loss of concentration, what they said to themselves, whether or not it was productive, and what they could have said or done that would have been more productive. In addition, both the Test Taking Module and the Concentration Management Module included a Slow Deep Breathing exercise to assist students in obtaining a "relaxed yet alert" state of mind. Copies of all these materials can be found in AFHRL-TR-79-43.

3.2.2 Study Skills Questionnaire. In order to assist instructors in identifying students in need of study skills remediation, a Study Skills Questionnaire was written to assess each student's opinion of his or her study skills in the four selected areas (Reading Comprehension, Memorization, Test Taking, Concentration Management). All students were to be given the Questionnaire after completing the first block and before beginning the last block of the course. The results of the first administration were intended to provide a preintervention measure and diagnostic information for instructors as to the type of study skills remediation that would be most appropriate for a particular student. The results of the second administration were intended to provide a post-intervention measure which, when combined with information on student performance in the course, could be used to evaluate the effectiveness of the Study Skills Modules.

3.2.2.1 Questionnaire Format. The Study Skills Questionnaire originally consisted of a total of 50 items which were divided among four subscales. There were 15 items in the Reading Comprehension subscale, 12 items each in the Memorization and Concentration Management subscales, and 11 items in the Test Taking subscale. Students were asked to respond to each item by selecting one of three to five options which either asked them to rate their skills compared with other students or to select one of several study techniques which most matched their normal study methods. A copy of the original Questionnaire can be found in AFHRL-TR-79-

3.2.2.2 Questionnaire Scoring Procedures. For both administrations of the Study Skills Questionnaire, students in the four AIS courses were asked to record their responses on an AIS Generalized Answer Sheet. Five variables were defined to the AIS data base for the scoring and recording of Questionnaire data: (a) a total Study Skills Questionnaire score, (b) a Reading Comprehension score, (c) a Memorization score, (d)

a Test Taking score, and (e) a Concentration Management score. The corresponding variables were defined as SSQUES, READCM, MEMORY, TSTTAK, and CONMGT to the AIS data base. All answer sheets were processed through AIS management terminals.

3.2.3 Instructor Orientation and Training. The major goal of the instructor package was to provide instructors with appropriate tools to help them become efficient diagnosticians, tutors, and/or remediators of student study skills deficiencies, thereby enabling them to help students become efficient learners. The Study Skills Modules were used in the Instructor Orientation and Training Workshops as a primary focus of the CMI student-instructor interaction. In addition, a purpose of this package was to provide instructors with specific tools which they could use to define their counselor role in a CMI environment.

3.2.3.1 Instructional Strategies and Procedures. Given that the Study Skills Package placed heavy emphasis on the instructor's role in (a) diagnosing student study skills problems via the Study Skills Questionnaire and (b) facilitating remediation of problem areas through assignment of the Study Skills Modules, volunteer instructors were given intensive training in the skills required in a 6-hour workshop. To elicit support for the program and obtain instructor volunteers for the workshop training, the investigators briefed instructors and supervisors in all four AIS courses on the purpose of the Study Skills Package and its various components (remediation modules, questionnaire, instructor training).

The basic approach in the workshop training was to provide instructors with an opportunity to analyze, discuss, and practice the techniques presented in each of the four Study Skills Modules. In addition, the workshops were designed to train instructors in basic problem solving, diagnostic, and communication skills (e.g., listening, probing), to practice these skills in role playing exercises, and to provide follow-up sharing of successes and/or problems in implementing their new diagnostic and tutorial skills.

3.2.3.2 Training Format and Evaluation Instruments. The Instructor Workshops were divided into three 2-hour sessions. The first session was devoted to explaining, discussing and practicing the use of the study techniques described in the four Study Skills Modules. The second session focused on problem solving skills, diagnostic strategies, and remediation procedures, including some training in listening and probing skills. These two sessions were held on consecutive days, and the third session was held approximately 1 week later. This third session was designed to give instructors a chance to discuss any problems or difficulties they had experienced in using the materials and procedures in their classrooms and to exchange information, solutions, suggestions, and interesting case histories.

Following the second session of the Instructor Workshop, it was the

instructor's responsibility to decide which students should receive which of the Study Skills Modules. When an instructor identified a student who was behind schedule or who had failed a block test, the instructor was to determine if the student's problem was in the area of poor study skills and, if so, to select the appropriate type of study skills remediation. Although these decisions could have been determined statistically, by other personnel, or even by the students themselves, it was hypothesized that giving instructors this responsibility was vital to the development of appropriate instructor roles. An instructor critique form was designed to assess instructor reactions to and comments about the workshops. This critique form contained 19 forced-choice ratings and one open-ended question. Copies of the materials used in the workshops and the critique form can be found in AFHRL-TR-79-43.

3.3 Formative Evaluation

As with the Orientation to CMI and Time Management Modules, the materials developed as part of the Study Skills Package were evaluated in two phases during formative evaluation. The first phase was a small-group tryout and the second phase was a more extensive operational tryout. The results of these evaluations are described separately for the Study Skills Modules, the Study Skills Questionnaire, and the Instructor Orientation and Training. Since extensive descriptions of the procedures and results of formative evaluation activities are described in AFHRL-TR-79- , only summaries of these procedures and results will be presented here.

3.3.1 Study Skills Modules. Small group tryouts of the four Study Skills Modules employed instructors from the four AIS courses, rather than students, for three main reasons:

1. It was hypothesized that if instructors were included in the formative evaluation of these materials, they would be more accepting of them during subsequent evaluations.

2. Since training in study skills techniques was part of the Instructor Orientation and Training, it was thought that instructor participation would be greater if their comments and suggestions were given validity and value.

3. Much of the material which was used in these modules had already been subjected to student evaluation by other researchers (e.g., Dansereau, Note 12; Weinstein, Note 15; Woodley, Note 16).

Following investigator briefings at each of the AIS courses, instructor volunteers were asked to read and complete a 12-item questionnaire on any one of the four Study Skills Modules. A list was also circulated for interested instructors to sign up for participation in the subsequent Instructor Workshops. One week later, the questionnaires and instructor comments were discussed with those instructors who had

volunteered to participate in the evaluation, and requests for additional instructor volunteers for the workshops were circulated.

Major findings from this small-group tryout were (a) instructors generally liked the modules and believed that they would be useful to at least some of their students, (b) instructors generally believed that students could take any of the modules by themselves, although they also felt instructors could give students tutorial assistance in the study skills techniques if necessary, and (c) a majority of the instructors felt that the modules were written at too difficult a level for most students and, therefore, needed to be revised to reduce the use of technical terms and to clarify the procedures described for the various study skills techniques. Based on these results, all modules were revised and generally simplified, with the most extensive changes being made to the Memorization Module.

The revised Study Skills Modules were subjected to an operational tryout in the IM, MF, and WM courses, in that instructor volunteers for workshop training were obtained from operational AIS blocks in these courses. (The instructor volunteers from the PME course were from non-AIS blocks). The operational evaluation time period was approximately 10 weeks, during which time the instructors identified students in need of one or more of the Study Skills Modules and assigned them to these modules either during the regular shift or as homework. The four Study Skills Modules were identified as lessons in the overall course hierarchy, a procedure which provided for the identification of which students per course were assigned which Study Skills Modules, without having the time spent on the module(s) count against their course completion time. This procedure was felt to be necessary to avoid the perception by students of any negative consequences being associated with study skills remediation.

The questions of primary interest during this operational tryout were whether those students who received one or more of the Study Skills Modules would (a) increase their scores on the Study Skills Questionnaire from the initial to end-of-course measurement periods, and (b) would improve their course performance (either times-to-complete or scores) following remedial study skills training. Thus, the evaluation employed a within-student design in which preliminary data on the effectiveness of the modules for improving performance were collected in the three AIS courses. A question of tangential interest was the number of students per course the instructor workshop participants would identify for study skills remediation.

The number of IM, MF, and WM students who were identified for and received one or more of the modules during the evaluation period are shown in Table 9. These data do not, however, reflect a completely accurate picture of the extent to which the instructors who participated in the workshops assigned these study skills materials. It was learned from the instructors and data clerks in the three courses that a number

TABLE 9

Number of Students Receiving Study Skills Materials During Operational Tryouts

COURSE	TOTAL STUDENTS WHO COMPLETED THE COURSE	STUDENTS WITH COMPLETE PERFORMANCE DATA	TOTAL WM STUDENTS STILL IN COURSE	WM STUDENTS WITH COMPLETE PERFORMANCE DATA
IM	7	5		
MF	2	0		
WM	2	1	10	5

of instructors had picked up materials for assignment to students, but had not identified the students to the AIS data base. A conservative estimate of the additional students is 10 in the IM course, 5 in the MF course, and 25 in the WM course.

Given the small number of students per course with sufficient performance data for analysis, individual students' pre/post block time and score data are reported in Table 10. These data are shown as standardized scores to allow comparisons of performance changes across courses with variable block lengths and block test difficulty levels. For each block, score and time means and standard deviations were computed for all students in each course during the evaluation period. The appropriate mean was subtracted from each student's (time or score) performance value for each block. The resultant value was then divided by the appropriate standard deviation. This procedure yielded an index for each student for each block which represented his or her performance relative to all other students. Finally, for each student, an average standard score was computed for both the student's pretreatment period and for the post-treatment period. It is these pre- and post-treatment scores which are reported in Table 10. Table 10 also indicates, by student, the particular Study Skills Module(s) which are assigned and reports the overall average pre/post standard scores per course.

As can be seen in Table 10, all five IM students improved their block times (a reduction in the standard score values) from pre to post study skills remediation, from an average of 2.86 standard deviations above the mean for pre-treatment, to an average of 1.30 standard deviations above the mean for post-treatment. Similarly, four of the six WM students improved their block times from pre to post study skills remediation, while two of the six students demonstrated some increase in block times. The average pre/post block time scores were 2.21 and 1.24, respectively, indicating an overall improvement in WM student

TABLE 10

Standardized Pre/Post Study Skills Remediation
Block Times and Scores for IM and WM Students

Course/ Student	Pre-Treatment Score	Post-Treatment Score	Modules Taken[a]
Block Time			
IM-1	1.77	1.57	RC, M, CM
IM-2	1.94	.09	RC, M, CM
IM-3	2.75	.89	RC
IM-4	5.45	2.00	RC, M, TT, CM
IM-5	2.40	1.96	TT
IM Average	2.86	1.30	
WM-1	2.48	-.84	RC, M, TT, CM
WM-2	2.34	1.40	RC, M, TT, CM
WM-3	1.89	1.22	RC, M, TT, CM
WM-4	4.51	2.60	RC, M, TT, CM
WM-5	.71	1.42	RC
WM-6	1.30	1.63	RC
WM Average	2.21	1.24	
Overall Average	2.54	1.27	
Block Score			
IM-1	-1.12	-.13	RC, M, CM
IM-2	-1.14	-.59	RC, M, CM
IM-3	-1.88	-.93	RC
IM-4	-2.24	-.29	RC, M, TT, CM
IM-5	- .89	.25	TT
IM Average	-1.45	-.34	
[b] WM-1			
WM-2	-1.82	.95	RC, M, TT, CM
WM-3	- .11	.30	RC, M, TT, CM
WM-4	-2.43	-.32	RC, M, TT, CM
WM-5	- .20	.51	RC
WM-6	- .10	.61	RC
WM Average	- .93	.41	
Overall Average	-1.19	.03	

[a] RC = Reading Comprehension; M = Memorization; TT = Test Taking; CM = Concentration Management

[b] No Pre/Post Score Data Available

block times of one standard deviation. It is also of interest that the WM students who were assigned all four Study Skills Modules all improved their block times, while the WM students who were assigned only the Reading Comprehension Module showed some increase in block times. It may be that increasing students' reading comprehension skills through the use of active information processing strategies increases their productive on-task time for WM course tasks, a possibility supported by the block score results shown on the bottom half of Table 10. The overall improvement in student block times, however, across the IM and WM courses indicates that study skills remediation led to an improvement of 2.54 to 1.27.

Pre/post block score changes for IM course students indicate that all five students improved (an increase in standard scores) their block scores following study skills remediation. The average improvement was from -1.45 to -.34. All five WM students with pre/post block scores also improved their performance following study skills remediation, with the average change being from -.93 to .41. Thus, an improvement in block scores was found, even for those WM students who were assigned only the Reading Comprehension Module. It is interesting to note that even though two of the IM students were assigned only one Study Skills Module, they made both time and score improvements following remediation. This may have been due to an appropriate instructor match of materials to student needs. The overall improvement in student block scores across the IM and WM courses was from -1.19 to .03--again in excess of one standard deviation.

Of those student samples enumerated in Table 9, only two IM students had data on both the initial and end-of-course administrations of the Study Skills Questionnaire. The data for these students on the total scale (SSQUES) and four subscales (READCM, MEMORY, TSTTAK, CONMGT) are shown in Table 11, along with a listing of the particular Study Skills Modules these students were assigned during the course. It is of interest to note that the student who received all four modules demonstrated the greatest improvement in his assessment of his study skills, whereas there was little change in the ratings of the student who received only the Reading Comprehension Module.

Finally, it was of interest to examine the time spent on each of the Study Skills Modules. Given that, of the 11 students in the IM and WM courses with data available for analysis, only three IM and one WM student took their module(s) during the training shift, it is only possible to suggest the time spent on the modules. Of the three IM students, times were available on the Reading Comprehension Module only, and these times-to-complete were 81, 109, and 86 minutes--a mean of 92 minutes. The WM student took 275 minutes to complete the four Study Skills Modules. Assuming a liberal 350 minutes for students to complete all four Study Skills Modules and a time savings of approximately one standard deviation for those students receiving study skills remediation, in the IM course (where the standard deviation in course completion time

TABLE 11

Changes in Student Scores on
Initial and End-of-Course Study Skills
Questionnaire Administrations

COURSE/ STUDENT	SCALE	INITIAL SCORE	END SCORE	MODULE(S) TAKEN
IM-1	SSQUES	69	70	Reading Comprehension
	READCM	19	21	
	MEMORY	18	17	
	TSTTAK	12	15	
	CONMGT	20	17	
IM-2	SSQUES	52	68	All 4 Modules
	READCM	24	21	
	MEMORY	10	20	
	TSTTAK	02	16	
	CONMGT	16	11	

is approximately 1600 minutes), a savings of approximately 1250 minutes out of an average completion time of approximately 7100 minutes (17.6 percent) would be realized for some percentage of the students. Similarly, in the WM course (where the standard deviation in course completion time is approximately 2300 minutes), a savings of approximately 1950 minutes out of an average completion time of approximately 11,700 minutes (16.7 percent) would be realized for some percentage of the students. These results suggest that the time required for study skills remediation compares favorably with the resulting savings in completion time.

3.3.2 Study Skills Questionnaire. Small group and operational tryouts of the Study Skills Questionnaire were conducted at the same time as the small-group tryouts of the Study Skills Modules. During this time (a period of approximately 3 weeks), the questionnaire was first reviewed by instructors in the four AIS courses. The results of this review indicated that instructors were generally satisfied with the content and format of the questionnaire. The questionnaire was then administered to those students in the IM, MF, WM, and PME courses who were beginning the second block of their course or who were beginning the last course block.

The question of primary interest in the operational tryouts was whether the initial 50-item Study Skills Questionnaire demonstrated satisfactory total scale and subscale reliability. Cronbach's alpha reliability coefficient was calculated on each course's pre- and post-

questionnaire data via the AIS Test Item Evaluation (TIE) program. Unfortunately, during this tryout period, student flow was low in all courses, and the sample sizes available for the TIE analyses were sufficient for suggestive results only (i.e., number of pre-scale samples ranged, across courses, from 7 to 16 and the number of post-scale samples ranged from 7 to 22). Given these small samples, a conservative approach was adopted to revisions--to drop only those items which consistently demonstrated low item remainder correlations with the total scale or appropriate subscales across all four of the AIS courses. This procedure resulted in deleting a total of 20 items from the questionnaire. Eight items were retained in the Reading Comprehension subscale, seven items in the Memorization subscale, six items in the Test Taking subscale, and nine items in the Concentration Management subscale (refer to AFHRL-TR-79-43 for a copy of the revised 30-item Study Skills Questionnaire).

3.3.3 Instructor Orientation and Training. Four instructors from the MF course and four instructors from the WM course participated in the small group tryouts of the Instructor Orientation and Training Workshops. The critique results indicated that the instructors were generally satisfied with the composition and format of the workshops. Those activities which were most popular were the explanations of the study skills techniques presented in the four Study Skills Modules, and the diagnostic question handouts and explanations. Other activities rated highly were the exercise in listing internal and external clues to student study skill problems, the examples of when communication problems occur, the passage on Attending Behavior, and the discussion of reflection and probing skills.

Based on these findings, the workshop procedures and content were modified slightly, such that some examples were made more relevant and participative discussion was emphasized. Additionally, it was decided to retain the Slow Deep Breathing exercise, even though several of the instructors had indicated feeling somewhat embarrassed about doing this exercise in a group setting. It was deemed particularly important for instructors to understand how this technique worked so that they would be in a position to recommend it to students experiencing test anxiety or having difficulty becoming relaxed while studying.

The operational tryouts of the Instructor Orientation and Training Workshops were conducted 2 weeks after the small group tryouts, and before the operational tryouts of the Study Skills Modules and Questionnaire. Forty-seven instructors initially volunteered to participate in the workshops and four sections were created, with 11 instructors assigned to each section. Due to summer leave and various job responsibilities, however, only half of these individuals actually participated: eight instructors each from the PME and IM courses and seven instructors from the WM course.

The results from the instructor critique form indicated that in-

structors generally liked the workshop sessions and believed that they were useful to them as instructors. It also appears that the revisions made following the small group tryouts were appropriate since all of the workshop activities were rated as "particularly liked" by a majority of the instructors. A description of the final content and format of the workshops can be found in AFHRL-TR-79-43.

3.4 Summative Evaluation

A second large scale tryout of components within the Study Skills Package was restricted to the Study Skills Questionnaire due to time and resource constraints.

3.4.1 Study Skills Questionnaire. The two questions of primary interest in the summative evaluation of the Study Skills Questionnaire were (a) whether the questionnaire demonstrated satisfactory reliability, as defined by an internal consistency measure and (b) whether it demonstrated acceptable validity in both a construct and predictive sense. To these ends, therefore, the revised 30-item questionnaire was implemented in all four AIS courses for a period of approximately nine weeks. For the purposes of validating the questionnaire, data from the initial administration (i.e., end of first course block) are most relevant. This is because the questionnaire was intended as a diagnostic pre-course or pre-treatment self-appraisal of student study skills. Therefore, data on the questionnaire administered to AIS students at the end of their first course block were utilized to determine the reliability and validity of the Study Skills Questionnaire.

3.4.1.1 Questionnaire Reliability Results. The means, standard deviations, and alpha reliability coefficients for the 30-item Study Skills Questionnaire (SSQUES), its 8-item Reading Comprehension (READCM) subscale, 7-item Memorization (MEMORY) subscale, 6-item Test Taking (TSTTAK) subscale, and 9-item Concentration Management (CONMGT) subscale are reported in Table 12 for the Inventory Management (IM), Materiel Facilities (MF), Precision Measuring Equipment (PME), and Weapons Mechanic (WM) courses. The AIS Test Item Evaluation (TIE) program was used in the calculation of all reliability results.

As Table 12 indicates, the alpha reliabilities of the SSQUES ranged from a low of .81 to a high of .95, indicating high internal consistencies for the total questionnaire across the four AIS courses. It should be noted that only in the WM course did the alpha reliability of the total scale drop below .90. The reliability data reported in Table 12 also indicate that (a) the alpha reliability of the READCM subscale ranged from a low of .58 to a high of .87, (b) the MEMORY subscale reliability ranged from a low of .35 to a high of .75, (c) the alpha reliability of the TSTTAK subscale ranged from a low of .48 to a high of .84, and (d) the CONMGT subscale alpha reliability ranged from a low of .82 to a high of .88. Again, reliability coefficients from the WM course tended to be lower on all subscales than the other AIS

TABLE 12

Means, Standard Deviations, and Alpha Reliabilities of Study Skills Questionnaire Total Scale and Subscales Administered in Four AIS Courses

Course	Scale	Score Range	N	Mean	SD	Alpha
IM	SSQUES	30 - 120	313	81.0	17.5	.95
	READCM	8 - 32	313	22.9	5.1	.87
	MEMORY	7 - 28	313	17.3	4.1	.73
	TSTTAK	6 - 24	313	16.6	4.0	.82
	CONMGT	9 - 36	313	24.1	6.1	.88
MF	SSQUES	30 - 120	92	81.7	16.1	.94
	READCM	8 - 32	92	23.2	4.5	.82
	MEMORY	7 - 28	92	16.7	4.0	.75
	TSTTAK	6 - 24	92	16.5	4.0	.84
	CONMGT	9 - 36	92	25.3	5.8	.88
PME	SSQUES	30 - 120	79	82.6	13.7	.91
	READCM	8 - 32	79	23.2	4.2	.80
	MEMORY	7 - 28	79	18.0	3.5	.55
	TSTTAK	6 - 24	79	16.8	3.2	.75
	CONMGT	9 - 36	79	24.6	5.1	.84
WM	SSQUES	30 - 120	297	85.1	9.3	.81
	READCM	8 - 32	297	24.1	2.3	.58
	MEMORY	7 - 28	297	18.2	2.5	.35
	TSTTAK	6 - 24	297	18.0	2.2	.48
	CONMGT	9 - 36	297	24.9	5.4	.82

courses, although the CONMGT subscale demonstrated consistently high reliability across all four AIS courses. One possible explanation for the lower reliability coefficients in the WM course data may be the generally lower variability in these data.

Item-remainder correlations of the individual SSQUES items, with both the total scale and the appropriate subscale, were determined separately for each AIS course. Tables 13 through 16 present the means, standard deviations and item-remainder correlations for the individual items for data from the IM, MF, PME, and WM courses, respectively.

As indicated in Tables 13 through 20, five items demonstrated consistently low item remainder correlations with their appropriate subscales across the four AIS courses. These items are: (a) Item 5 on the READCM scale, (b) Items 9, 12, and 14 on the MEMORY scale, and (c) Item 18 on the TSTTAK scale. These items are candidates for subsequent revision to increase the overall reliability of the Study Skills Questionnaire and of its subscales.

3.4.1.2 Questionnaire Validity Results. The validity of the Study Skills Questionnaire was assessed in two ways. First, its construct validity was addressed by determining the extent to which the questionnaire and its subscales demonstrated moderately high intercorrelations and consistent conceptual groupings across the four AIS courses. These construct validity questions were assessed by correlational and factor analyses, respectively. Second, its predictive validity was addressed by determining the extent to which the questionnaire and its subscales were predictive of student performance, in general, and of the performance of particular subgroups. These questions were assessed by discriminant analyses. Routines from the Statistical Package for the Social Sciences (SPSS; Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975) were utilized in the foregoing analyses.

3.4.1.2.1 Construct Validity. As evidence of the construct validity of the SSQUES and its READCM, MEMORY, TSTTAK, and CONMGT subscales, intercorrelation matrices were calculated separately for student data on these measures from each of the four AIS courses. These matrices are shown in Tables 17 through 20 for the IM, MF, PME and WM courses, respectively. The results generally indicate moderate to moderately high intercorrelations between the SSQUES and its subscales, suggesting that the four subscales of the SSQUES are within the same student characteristic variable domain.

A further examination of the Questionnaire's construct validity was conducted via factor analyses of IM and WM course data. Only these two courses had sample sizes considered adequate for this statistical methodology. Data from the SSQUES and four subscales were combined with student data on the set of affective and cognitive preassessment variables assessed at the beginning of the courses. Descriptions of the variables included in the IM preassessment battery are given in Table 21,

TABLE 13

Means, Standard Deviations, and Item-Remainder Correlations for Study Skills Questionnaire Total Scale and Subscales in IM Course (N=313)

Subscale/Item		Mean	SD	Item Remainder Total	Item Remainder Subscale
READCM	1	2.72	.92	.62	.65
	2	3.05	1.04	.55	.48
	3	2.71	.74	.77	.70
	4	2.69	.80	.67	.63
	5	2.91	.91	.59	.58
	6	3.32	.93	.68	.68
	7	2.77	.89	.71	.60
	8	2.77	.89	.69	.66
MEMORY	9	2.60	1.03	.49	.35
	10	2.41	.78	.69	.58
	11	2.86	.86	.73	.63
	12	2.05	.99	.33	.26
	13	2.05	.95	.38	.40
	14	2.63	1.14	.39	.39
	15	2.70	.75	.79	.63
TSTTAK	16	2.82	.78	.73	.71
	17	3.15	.98	.61	.51
	18	2.59	1.02	.43	.37
	19	2.65	.83	.69	.66
	20	2.32	.86	.65	.64
	21	3.10	1.05	.69	.65
CONMGT	22	2.67	.79	.77	.71
	23	2.43	.84	.69	.70
	24	2.69	.99	.60	.60
	25	2.69	.90	.66	.67
	26	2.68	.96	.63	.60
	27	2.48	.89	.62	.62
	28	2.69	.94	.73	.70
	29	2.94	1.03	.59	.57
	30	2.86	1.11	.59	.60

TABLE 14

Means, Standard Deviations, and Item-Remainder Correlations for Study Skills Questionnaire Total Scale and Subscales in MF Course (N=92)

Subscale	Item	Mean	SD	Item Remainder	
				Total	Subscale
READCM	1	2.72	.86	.60	.57
	2	3.14	1.03	.53	.51
	3	2.61	.66	.66	.57
	4	2.86	.79	.58	.55
	5	2.83	.82	.52	.51
	6	3.30	.92	.60	.55
	7	2.80	.84	.72	.55
	8	2.91	.85	.58	.52
MEMORY	9	2.53	.93	.54	.24
	10	2.34	.86	.62	.55
	11	2.86	.76	.74	.65
	12	1.93	.97	.34	.33
	13	1.97	.88	.47	.60
	14	2.46	1.13	.31	.39
	15	2.60	.80	.71	.61
TSTTAK	16	2.84	.77	.73	.71
	17	3.11	.92	.60	.49
	18	2.77	.93	.52	.46
	19	2.60	.77	.69	.72
	20	2.25	.83	.68	.66
	21	2.91	1.08	.65	.70
CONMGT	22	2.79	.76	.69	.72
	23	2.64	.90	.61	.64
	24	2.84	.91	.65	.65
	25	2.84	.83	.65	.66
	26	2.76	.97	.56	.65
	27	2.58	.91	.52	.50
	28	2.67	.88	.65	.58
	29	3.05	.95	.59	.66
	30	3.15	.96	.64	.61

TABLE 15

Means, Standard Deviations, and Item-Remainder Correlations for Study Skills Questionnaire Total Scale and Subscales in PME Course (N=79)

Subscale	Item	Mean	SD	Item Remainder Total	Item Remainder Subscale
READCM	1	2.84	.79	.51	.53
	2	3.20	.88	.58	.51
	3	2.70	.77	.65	.57
	4	2.77	.72	.60	.50
	5	2.65	.99	.40	.38
	6	3.39	.76	.67	.65
	7	2.73	.73	.60	.49
	8	2.91	.77	.63	.57
MEMORY	9	2.34	1.04	.48	.35
	10	2.43	.80	.49	.51
	11	2.86	.76	.58	.46
	12	1.94	1.28	.20	.06
	13	2.68	.97	.28	.03
	14	2.96	1.01	.28	.24
	15	2.81	.68	.62	.57
TSTTAK	16	2.81	.62	.61	.56
	17	3.28	.88	.59	.48
	18	2.65	.82	.28	.25
	19	2.82	.66	.58	.56
	20	2.18	.78	.40	.50
	21	3.10	1.00	.61	.67
CONMGT	22	2.77	.62	.77	.71
	23	2.58	.71	.63	.59
	24	2.72	.89	.44	.33
	25	2.70	.74	.60	.61
	26	2.70	.91	.61	.55
	27	2.47	.92	.56	.57
	28	2.68	.84	.71	.64
	29	3.05	.86	.63	.60
	30	2.91	1.12	.48	.52

TABLE 16

Means, Standard Deviations, and Item-Remainder Correlations for Study Skills Questionnaire Total Scale and Subscales in WM Course (N=297)

				Item Remainder	
Subscale	Item	Mean	SD	Total	Subscale
READCM	1	3.00	.69	.44	.46
	2	3.35	.73	.19	.23
	3	2.80	.56	.36	.29
	4	2.68	.67	.28	.22
	5	2.83	.70	.17	.15
	6	3.44	.69	.23	.26
	7	3.05	.70	.50	.29
	8	2.93	.74	.44	.39
MEMORY	9	2.60	.88	.22	-.01
	10	2.49	.71	.38	.33
	11	3.05	.65	.62	.30
	12	2.21	.90	.14	.07
	13	2.12	.86	.04	.15
	14	2.81	.98	-.10	.05
	15	2.87	.52	.45	.37
TSTTAK	16	3.04	.53	.30	.27
	17	3.21	.74	.32	.16
	18	2.77	.86	-.05	-.04
	19	2.90	.57	.53	.44
	20	2.67	.72	.47	.35
	21	3.38	.75	.55	.44
CONMGT	22	2.88	.58	.36	.18
	23	2.71	.77	.54	.62
	24	2.89	.78	.47	.53
	25	2.89	.77	.51	.60
	26	2.65	.90	.59	.62
	27	2.46	.91	.56	.57
	28	2.85	.83	.57	.56
	29	2.76	1.27	.42	.54
	30	2.80	1.32	.48	.60

TABLE 17

Intercorrelations of Initial Measure of Study Skills Questionnaire Variables in IM Course (N=267)

	READCM	MEMORY	TSTTAK	CONMGT	SSQUES
READCM	1.00	.37	.43	.55	.77
MEMORY		1.00	.39	.26	.65
TSTTAK			1.00	.41	.72
CONMGT				1.00	.77
SSQUES					1.00

All above correlations are significant at the $p < .001$ level.

TABLE 18

Intercorrelations of Initial Measure of Study Skills Questionnaire Variables in MF Course (N=90)

	READCM	MEMORY	TSTTAK	CONMGT	SSQUES
READCM	1.00	.40	.48	.50	.76
MEMORY		1.00	.61	.37	.78
TSTTAK			1.00	.41	.77
CONMGT				1.00	.72
SSQUES					1.00

All above correlations are significant at the $p < .001$ level.

TABLE 19

Intercorrelations of Initial Measure of Study Skills Questionnaire Variables in PME Course (N=80)

	READCM	MEMORY	TSTTAK	CONMGT	SSQUES
READCM	1.00	.47	.38	.67	.84
MEMORY		1.00	.23*	.44	.64
TSTTAK			1.00	.46	.64
CONMGT				1.00	.88
SSQUES					1.00

* $p < .05$; all other correlations are significant at the $p < .001$ level.

TABLE 20

Intercorrelations of Initial Measure of Study Skills Questionnaire Variables in WM Course (N=271)

	READCM	MEMORY	TSTTAK	CONMGT	SSQUES
READCM	1.00	.38	.48	.48	.78
MEMORY		1.00	.41	.22*	.62
TSTTAK			1.00	.39	.71
CONMGT				1.00	.81
SSQUES					1.00

* $p < .01$; all other correlations are significant at the $p < .001$ level.

TABLE 21: Description of IM Course Preassessment Testing Battery

Factor	Test and Subscale Names	Test Descriptions	Author
Reading/ Reasoning	Logical Reasoning Test (LOGREA)	Measures student's general ability to judge the logical soundness of meaningful conclusions.	Hertzka & Guilford (1955)
Reading/ Reasoning	IM Reading Skills Scale Reading Scale 1 (READS1) Reading Scale 2 (READS2)	Measures student's technical information processing and retention skills, under timed conditions, on materials extracted from IM and MF technical manuals.	McCombs (Note 21)
Reading/ Reasoning	Reading Vocabulary Test (RVOCTL)	Measures student's comprehension, under timed conditions, of terms frequently used in Air Force documents and manuals.	Deignan (Note 22)
Anxiety Curiosity	Attitude Toward Course Materials State Anxiety (STANX) State Curiosity (STCUR)	Measures how tense or apprehensive versus interested or motivated a student feels about learning the IM course materials on an intensity dimension.	Spielberger, Gorsuch & Lushene (1970); McCombs-Leherissey (Note 23)
Anxiety	Test Attitude Inventory (TAITL) Test Worry (TAIWY) Test Emotionality (TAIEM) Test Anxiety (TAIEX)	Measures, on a frequency dimension, student's tendency to feel cognitive worry versus emotional versus generally anxious when taking performance or achievement tests.	Spielberger (*in press*) (Note 24)
Anxiety	General Attitude Scale Trait Anxiety (TRANX) Trait Curiosity (TRCUR)	Measures student's general tendency to experience feelings of tension and apprehension in situations perceived as threatening versus feelings of interest in a variety of technical areas.	Spielberger et al. (1970); Day (Note 25)
Media Preference Media Experience	General Media Preference Scale Visual (PREFV) Audio (PREFA) Print (PREFP) Conventional (EXPCI) Self-Paced (EXPSP)	Measures student's preference for visual versus audio versus printed learning materials, as well as his/her experience with conventional versus self-paced instructional methods	McCombs (Note 26)

along with the appropriate variable labels. The results of the IM factor analysis are shown in Table 22. As can be seen, the study skills variables formed a separate factor following the Varimax rotation procedure. Six definable factors were derived from the preassessment and study skills variables, with the variables from the Study Skills Questionnaire loading on the third factor. Of interest for the construct validity question is that (a) the READCM scale tended to load positively on the Reading/Reasoning, Curiosity, and Media Experience factors, (b) the MEMORY scale tended to load positively on the Reading/Reasoning factor, (c) the TSTTAK scale tended to load negatively on the Anxiety factor and positively on the Reading/Reasoning factor, (d) the CONMGT scale tended to load negatively on the Anxiety factor and positively on the Curiosity factor, and (e) the SSQUES total scale tended to load negatively on the Anxiety factor and positively on the Reading/Reasoning factor.

Descriptions of the variables included on the WM preassessment battery are given in Table 23, together with the appropriate variable labels. The factor analysis results for the WM course, shown in Table 24, are similar to those found in the IM course. Seven definable factors were derived from the WM preassessment and study skill variable set, with Study Skills Questionnaire variables loading on the second factor. Other findings of interest were that (a) the READCM scale tended to load negatively on the Anxiety factor and positively on the Curiosity factor, (b) the MEMORY scale tended to load negatively on the Anxiety factor and positively on the multiple Media Preference factor, (c) the TSTTAK scale tended to load negatively on the Anxiety factor, (d) the CONMGT scale tended to load negatively on the multiple Media Preference factor and positively on the Curiosity factor, and (e) the SSQUES total scale tended to load negatively on the Anxiety factor and on the multiple Media Preference factor.

The differential relationships shown in the IM and WM course factor analysis results suggest that, within different trainee populations, different patterns of cognitive and affective student characteristic variables are related to the students' ratings of their study skills in the reading comprehension, memorization, test taking, and concentration management areas. In addition to the findings of theoretically meaningful but differential factor analytic relationships, the data in both courses revealed a conceptually distinct study skills factor, indicating support for the construct validity of the Study Skills Questionnaire. Also of relevance is the finding that both cognitive and affective variables tend to be related to variables in the study skills domain, suggesting the need for both cognitive and affective remedial strategies in dealing with study skills problems.

3.4.1.2.2 Predictive Validity. The question of whether the Study Skills Questionnaire and its subscales could reliably predict student performance in the four AIS courses was examined by a discriminant analysis approach.

TABLE 22

Varimax Rotated Factor Matrix for IM Course Study Skills Questionnaire and Preassessment Variables (N = 213)

VARIABLES	FACTOR 1 (Anxiety)	FACTOR 2 (Reading/Reasoning)	FACTOR 3 (Study Skills)	FACTOR 4 (Curiosity)	FACTOR 5 (Media Experience)	FACTOR 6 (Media Preference)
READCM	-.186	.210	<u>.669</u>	.240	.224	-.086
MEMORY	-.118	.178	<u>.489</u>	-.033	-.009	-.035
TSTTAK	-.469	.335	<u>.480</u>	-.101	.052	-.046
CONMGT	-.303	.001	<u>.633</u>	.177	.099	-.141
SSQUES	-.341	.207	<u>.923</u>	.101	.116	-.108
READS1	-.068	<u>.561</u>	.082	.090	.125	.013
READS2	-.132	<u>.592</u>	.084	.141	.079	-.178
RVOCTL	-.191	<u>.604</u>	.148	.004	.106	.019
LOGREA	-.106	<u>.461</u>	.141	.033	.036	.091
STANX	<u>.590</u>	-.138	-.236	-.310	-.013	.148
STCUR	-.314	.091	.140	<u>.661</u>	.062	-.202
TRANX	<u>.538</u>	-.136	-.274	-.372	-.015	.085
TRCUR	-.052	.119	.036	<u>.649</u>	.101	.039
TAITL	<u>.961</u>	-.158	-.201	-.058	-.038	.094
TAIWY	<u>.807</u>	-.161	-.252	-.043	-.017	.084
TAIEM	<u>.891</u>	-.109	-.153	-.052	-.040	.064
TAIEX	<u>.816</u>	-.213	-.186	-.126	-.045	.159
PREFA	.181	-.003	-.056	.165	-.072	<u>.478</u>
PREFV	.068	.007	-.058	-.089	.137	<u>.492</u>
PREFP	-.032	.005	.111	.322	.090	<u>-.487</u>
EXPCI	-.064	.213	.100	.117	<u>.691</u>	.058
EXPSP	-.007	.110	.109	.055	<u>.760</u>	-.025

TABLE 23: Description of WM Course Preassessment Testing Battery

Factor	Test and Subscale Names	Test Descriptions	Author
Reading/ Reasoning	WM Reading Skills Scale Reading Scale 1 (READS1) Reading Scale 2 (READS2)	Measures student's reading comprehension and speed on materials extracted from WM technical orders and technical manuals.	McCombs (Note 21)
Reading/ Reasoning	Reading Vocabulary Test (RVOCTL)	Measures a student's comprehension, under timed conditions, of terms frequently used in Air Force document and manuals.	Deignan (Note 22)
Math Skills	Ship Destination Test (SHIPDS)	Measures student's general arithmetic reasoning or problem solving ability, using specific rules to solve problems under timed conditions.	Christensen & Guilford (1955)
Math Skills	Math Familiarization Test (MATHFT) Scale 1 (MATHF1) Scale 2 (MATHF2)	Measures student's basic math skills, *under timed conditions*, on easy and difficult subscales, that are required in certain areas of the WM course.	ATC-Developed
Anxiety Curiosity	Attitude Toward Course Materials State Anxiety (STANX) State Curiosity (STCUR)	Measures how tense or apprehensive versus interested or motivated a student feels about learning the WM course materials on an intensity dimension.	Spielberger, Gorsuch & Lushene (1970); McCombs-Leherissey (Note 23)
Anxiety	General Attitude Scale Trait Anxiety (TRANX) Trait Curiosity (TRCUR)	Measures, on a frequency dimension, student's general tendency to experience feelings of tension and apprehension in situations perceived as threatening versus feelings of interest in a variety of technical areas.	Spielberger et al. (1970); Day (Note 25)

TABLE 23 (Continued)

Factor	Test and Subscale Names	Test Descriptions	Author
Curiosity	Mechanical Curiosity Scale (MECCUR)	Measures student's general feelings of interest, or tendency to become interested in, mechanical devices and mechanical principles.	Unknown
Anxiety	Test Attitude Inventory (TAITL) Test Worry (TAIWY) Test Emotionality (TAIEM) Test Anxiety (TAIEX)	Measures, on a frequency dimension, student's tendency to feel cognitive worry versus emotional versus generally anxious when taking performance or achievement tests.	Spielberger (in press) (Note 24)
Media Preference	General Media Preference Scale Visual (PREFV) Audio (PREFA) Print (PREFP)	Measures student's preference for visual versus audio versus printed learning modes, as well as his/her experience with conventional versus self-paced instructional methods.	McCombs (Note 26)
Media Experience	Conventional (EXPCI) Self-Paced (EXPSP)		

TABLE 24

Varimax Rotated Factor Matrix for WM Course Study Skills
Questionnaire and Preassessment Variables (N = 271)

VARIABLES	FACTOR 1 (Anxiety)	FACTOR 2 (Study Skills)	FACTOR 3 (Math Skills)	FACTOR 4 (Media Preference)	FACTOR 5 (Curiosity)	FACTOR 6 (Reading/ Reasoning)	FACTOR 7 (Media Experience)
READCM	-.202	<u>.666</u>	.063	-.121	.238	.050	.055
MEMORY	-.200	<u>.611</u>	.023	.218	-.010	.090	-.039
TSTTAK	<u>-.488</u>	<u>.540</u>	.093	-.023	.060	.095	.064
CONMGT	-.167	<u>.590</u>	.087	<u>-.456</u>	.215	-.069	.056
SSQUES	-.303	<u>.927</u>	.088	-.206	.171	.032	.047
READS1	-.028	.073	.104	-.075	.015	<u>.455</u>	.072
READS2	-.062	-.049	.093	-.001	.075	<u>.510</u>	.088
RVOCTL	-.216	.127	.173	-.061	-.029	<u>.511</u>	.099
SHIPDS	-.143	.051	<u>.330</u>	.070	-.020	<u>.358</u>	.047
STANX	<u>.563</u>	-.251	-.134	.039	-.398	-.048	-.154
STCUR	-.250	.215	.016	-.003	<u>.647</u>	.166	.064
MECCUR	-.009	.124	-.017	.049	<u>.692</u>	-.054	.197
PREFV	.137	-.036	-.002	<u>.482</u>	.154	-.052	.044
PREFA	.146	.147	-.047	<u>.462</u>	.034	-.319	.040
PREFP	-.063	.124	-.023	<u>-.487</u>	.094	-.036	-.073
EXPCI	.008	.061	-.007	.066	.146	.159	<u>.679</u>
EXPSP	-.061	.002	.076	.080	.100	.115	<u>.685</u>
MATHF1	.036	.059	<u>.511</u>	.035	-.003	.140	-.049
MATHF2	-.150	.047	<u>.881</u>	-.073	.025	.149	.109
MATHFT	-.109	.058	<u>.995</u>	-.044	.025	.164	.061
TAIWY	<u>.829</u>	-.232	-.054	.156	-.098	-.143	-.008
TAIEM	<u>.895</u>	-.164	-.008	.135	-.031	-.123	.051
TAIEX	<u>.829</u>	-.217	-.128	.127	-.048	-.132	-.069
TAITL	<u>.959</u>	-.205	-.052	.150	-.059	-.136	.003

The purpose of these analyses was to determine if the various study skills variables could reliably distinguish students in the least efficient and least effective quartiles, on the block and lesson completion time and score criterion variables, from those remaining 75 percent of the students who were having less difficulty completing the course quickly and successfully. These analyses were restricted to the IM and WM courses since these courses had the largest numbers of student samples available on the Study Skills Questionnaire administered at the end of the first block.

In the IM course, block level data considered appropriate for discriminant analyses were block completion times on Blocks 2 through 5, block test failures on an early (Block 2) and a late (Block 5) block, and block test scores on these same two blocks. In addition, cumulative lesson completion times and average lesson test scores were examined for these two blocks.

Results of the discriminant analyses on the IM block level data are reported in Table 25. The results indicated that the study skills variables were moderately effective in discriminating slow from fast students, correctly classifying between 61.3 and 69.8 percent of the students, with a slight gain in predictability from the early to later blocks. When completion times across the four blocks were summed, the scales were quite effective in reliably discriminating the slowest 25 percent of the students from the remaining students, correctly classifying 67.8 percent of the students.

With respect to number of block test failures, the scales were moderately effective in discriminating students with one or more block test failures from those who passed the block tests on the first attempt. In this case, predictability actually improved somewhat from the second (58.2 percent correctly classified) to the fifth (61.8 percent correctly classified) block.

Finally, it was considered of interest to determine the scales' power to discriminate in the bottom quarter of the block test score distribution from the remaining 75 percent. Again, the scales were found to be quite effective in discriminating between these two groups and, again, predictability was found to improve slightly from the second to the fifth block (63.0 versus 64.3 percent correctly classified). When Block 2 through 5 scores were summed and the lowest 25 percent discriminated from the remaining 75 percent, 65.1 percent of the students were correctly classified.

In general, the MEMORY, SSQUES, and CONMGT scales appeared to be most effective in predicting block times, while the SSQUES, MEMORY, and TSTTAK scales were most effective in predicting block failures and test scores.

Results of the lesson level discriminant analyses on the early

TABLE 25

IM Course Discriminant Analysis Results for Block Level Data

Criterion Variables	Bottom 25% Cutoff	N	Remaining 75% Cutoff	N	X^2	% Correctly Classified	Order of Predictors
Block 2 Time (in minutes)	⩾1877	67	< 1877	202	36.4**	68.4%	MEMORY SSQUES READCM CONMGT TSTTAK
Block 3 Time (in minutes)	⩾1678	72	< 1678	220	24.2**	64.4%	MEMORY SSQUES CONMGT READCM TSTTAK
Block 4 Time (in minutes)	⩾1154	71	< 1154	211	14.5**	61.3%	CONMGT MEMORY READCM TSTTAK
Block 5 Time (in minutes)	⩾1733	74	< 1733	221	46.4**	69.8%	SSQUES MEMORY READCM CONMGT TSTTAK
Block 2-5 Time (in minutes)	⩾6545	61	< 6545	181	30.6**	67.8%	MEMORY SSQUES CONMGT READCM TSTTAK
Block 2 Failures	⩾1	45	0	168	5.8*	58.2%	CONMGT TSTTAK SSQUES
Block 3 Failures	⩾1	70	0	158	12.8**	61.8%	MEMORY TSTTAK SSQUES
Block 2 Score	< 73	79	⩾73	221	20.3**	63.0%	SSQUES MEMORY READCM CONMGT TSTTAK
Block 5 Score	< 69	60	⩾69	240	24.7**	64.3%	MEMORY SSQUES TSTTAK CONMGT READCM
Block 2-5 Score	< 296	74	⩾296	224	27.2**	65.1%	TSTTAK SSQUES MEMORY CONMGT READCM

* $p < .01$ ** $p < .001$

(Block 2) and late (Block 5) blocks of the IM course are shown in Table 26. Again, it should be noted that the analyses examined the performance of the bottom 25 percent of the students from the remaining 75 percent with respect to lesson completion times and scores. The cutoff values shown refer to cumulative lesson completion times and average first attempt lesson test scores for all of the lessons within each of the blocks. The study skills scales were found to be moderately effective in reliably discriminating between these two groups on both the time and score dimensions, with the percent of students correctly classified ranging from 61.2 to 66.1 percent. It is important to note that there was no great loss (apparently, in fact, a slight gain for the time variable) in predictability from the early to the later block. The TTSTAK and SSQUES total scales were most effective in discriminating between groups on the time dimension, while TSTTAK and CONMGT scales appeared to do the best job in discriminating between groups with respect to lesson scores.

In the WM course, which consisted of 14 blocks, the number of cases available in the later blocks was consistently less than 100 per block, which would imply large instability in parameter estimation. Therefore, the block level data considered appropriate for analysis in the WM course consisted of block completion times for Blocks 2 through 8, block test failures on an early (Block 2) and a relatively late (Block 8) block, and block test scores on these same two blocks. Cumulative lesson completion times and average lesson test scores were also examined for these two blocks.

Results of the discriminant analyses for the WM block level data are reported in Table 27. The same procedures were followed as for the IM course analyses. The results indicated that the study skills variables were moderately effective in discriminating inefficient (lowest 25 percent) from efficient (remaining 75 percent) students with respect to individual block completion times. Excluding Blocks 3 and 7, (in which the chi-square values were not significant at the $p < .05$ level), between 61.0 and 75.7 percent of the students were correctly classified. It is likely that the classification failure in Block 7 could be attributed to the fact that almost all of the instruction in this block was presented via audio-visual media and thus was largely device-paced rather than being as dependent on student efficiency. When completion times were summed across the seven blocks, the scales were quite effective in reliably discriminating the slowest 25 percent of the students from the remaining 75 percent, correctly classifying 68.9 percent of the students.

In Blocks 2 and 8, the scales were highly effective in discriminating students with one or more block test failures from those who passed the block tests on the first attempt. As had been the case for the IM course, predictability actually increased from the earlier (Block 2, 68.3 percent correctly classified) to the later (Block 8, 71.9 percent correctly classified) blocks.

TABLE 26

IM Course Discriminant Analysis Results for Lesson Level Data

Criterion Variables	Bottom 25% Cutoff	Bottom 25% N	Remaining 75% Cutoff	Remaining 75% N	X^2	% Correctly Classified	Order of Predictors
Block 2							
Lesson Time	> 1732	55	≤ 1732	164	11.0*	61.2%	TSTTAK SSQUES MEMORY CONMGT
Lesson Score	< 579	55	≥ 579	172	18.6**	64.3%	TSTTAK SSQUES CONMGT READCM MEMORY
Block 5							
Lesson Time	> 1416	71	≤ 1416	209	28.9**	66.1%	SSQUES MEMORY READCM CONMGT TSTTAK
Lesson Score	< 606	70	≥ 606	217	18.6**	62.7%	CONMGT SSQUES MEMORY TSTTAK READCM

* $p < .01$.
** $p < .001$.

TABLE 27

WM Course Discriminant Analysis Results for Block Level Data

Criterion Variables	Bottom 25% Cutoff	N	Remaining 75% Cutoff	N	X^2	% Correctly Classified	Order of Predictors
Block 2 Time (in minutes)	⩾ 451	38	< 451	106	38.0***	75.7%	SSQUES CONMGT READCM TSTTAK
Block 3 Time (in minutes)	⩾ 583	38	< 583	108	1.8	55.5%	
Block 4 Time (in minutes)	⩾ 428	36	< 428	107	5.1*	59.4%	SSQUES MEMORY READCM CONMGT TSTTAK
Block 5 Time (in minutes)	⩾ 1603	34	< 1603	102	6.6**	61.0%	SSQUES TSTTAK READCM CONMGT MEMORY
Block 6 Time (in minutes)	⩾ 1448	32	< 1448	94	6.2*	61.1%	SSQUES TSTTAK MEMORY CONMGT READCM
Block 7 Time (in minutes)	⩾ 624	35	< 624	106	2.1	56.0%	
Block 8 Time (in minutes)	⩾ 1569	35	< 1569	104	18.7**	68.3%	SSQUES TSTTAK READCM MEMORY CONMGT
Block 2-8 Time (in minutes)	> 6496	13	⩽ 6496	61	10.6**	68.9%	READCM SSQUES MEMORY TSTTAK
Block 2 Failures	⩾ 1	258	0	13	36.2***	68.3%	MEMORY TSTTAK CONMGT READCM
Block 8 Failures	⩾ 1	129	0	10	26.8***	71.9%	READCM TSTTAK SSQUES CONMGT

TABLE 27 (Continued)

Criterion Variables	Bottom 25% Cutoff	N	Remaining 75% Cutoff	N	X^2	% Correctly Classified	Order of Predictors
Block 2 Score	< 72	21	≥ 72	125	2.7	56.8%	READCM TSTTAK MEMORY CONMGT SSQUES
Block 8 Score	< 71	36	≥ 71	110	5.4*	59.6%	TSTTAK SSQUES CONMGT READCM
Block 2-8 Score	< 545	13	≥ 545	62	11.2**	69.3%	READCM MEMORY CONMGT SSQUES

* $p < .05$.
** $p < .01$.
*** $p < .001$.

The four study skills scales were only fairly effective in discriminating the lowest 25 percent of the students from the remaining 75 percent with respect to the block test score distribution, with 56.8 percent of the students classified in Block 2 (chi-square not significant at $p < .05$), and 59.6 percent correctly classified in Block 8. When Block 2 through 8 scores were summed, however, the discrimination results were much improved, with 69.3 percent of the students correctly classified.

In general, the SSQUES total scale was most effective in predicting block completion times, while the READCM and TSTTAK scales were most effective in predicting block test failures and scores.

Results of the lesson level discriminant analyses on the early (Block 2) and late (Block 8) portions of the WM course are presented in Table 28. As was the case for the IM lesson level analyses, the two student categories defined on each (time and score) dimension were those considered to be displaying unsatisfactory (bottom 25 percent) or satisfactory (remaining 75 percent) performance. Again, the cutoff values shown pertain to cumulative lesson completion times across all lessons in the block and average first attempt lesson test scores for all lessons having cognitive criterion tests. The study skills scales were moderately effective in discriminating between the two groups in terms of time (61.0 and 68.2 percent correctly classified), but were less effective

TABLE 28

WM Course Discriminant Analysis Results for Lesson Level Data

Criterion Variables	Bottom 25% Cutoff	N	Remaining 75% Cutoff	N	X^2	% Correctly Classified	Order of Predictor
Block 2							
Lesson Time	> 422	68	≤ 422	199	13.0*	61.0%	SSQUES CONMGT READCM MEMORY TSTTAK
Lesson Score	< 151	59	≥ 151	222	2.6	54.8%	SSQUES MEMORY CONMGT TSTTAK READCM
Block 8							
Lesson Time	> 602	28	≤ 602	82	14.6*	68.2%	SSQUES TSTTAK READCM CONMGT
Lesson Score	< 307	36	≥ 307	109	3.7	57.9%	TSTTAK READCM CONMGT MEMORY SSQUES

* $p < .01$.

in discriminating between groups on the score dimension (54.8 and 57.9 percent correctly classified). Once again, there is a consistent pattern of increasing predictability from the earlier to the later block. The SSQUES total and TSTTAK scales appeared to be the most effective in discriminating students categorized into the Low Group from those in the High Group, with SSQUES being more effective on the time dimension and TSTTAK on the score dimension.

Finally, of interest in assessing the predictive validity of the Study Skills Questionnaire and its subscales was the question of the relative power of these variables to discriminate the poorest 25 percent of students on the lesson and block time and score dimensions from the remaining 75 percent of the students, as compared with the standard set

of preassessment predictors utilized in the IM and WM courses. To answer this question, the same set of discriminant analyses were calculated on the IM and WM course data as had been calculated with only the Study Skills Questionnaire variables. For the IM course, the preassessment predictor set consisted of 24 course-specific cognitive, affective, and background information predictors; for the WM course, the preassessment predictor set consisted of 26 course-specific predictors.

The results of the IM course analyses generally indicated that the preassessment set correctly classified approximately (a) 3 percent more students on the block time criterion, (b) 9 percent more students on the block score criterion, (c) an average of five percent more students on the lesson time criterion, and (d) an average of 4 1/2 percent more students on the lesson score criterion, as compared to the Questionnaire analyses. The WM course analyses yielded similar results, indicating that the preassessment set correctly classified approximately (a) 21 percent more students on the block time criterion, (b) 11 percent more students on the block score criterion, (c) an average of 5 percent more students on the lesson time criterion, and (d) an average of 15 percent more students on the lesson score criterion, as compared to the Questionnaire analyses. Thus, the larger preassessment sets were able to correctly classify a larger proportion of the students, particularly at the block level in the WM course. An additional set of discriminant analyses, however, which utilized variables from both the Questionnaire and preassessment sets indicated that for both the IM and WM courses, all five of the Study Skills Questionnaire variables were in the set of the most significant predictors of group membership for the lesson and block level analyses (as defined by changes in Raos V discrimination index). These results imply that the Questionnaire variables are measuring additional factors important to the prediction of student performance in a CMI environment, which was also substantiated in the factor analysis results.

In summary, these results indicate that the Study Skills Questionnaire and its subscales demonstrated good preliminary construct validity in both the IM and WM courses, and promising predictive validity. With respect to predictive validity, it is particularly important to note that the degree to which the scales correlated with subsequent student performance did not decrease as a function of time in the course and, in several cases, actually improved. It is also of interest that different patterns of predictor relationships were found for differing criterion variables, suggesting that the study skills variables are sensitive predictors of both different kinds of CMI criteria (time, score) and different kinds of course content (IM, WM blocks or lessons). In addition, although the smaller set of Study Skills Questionnaire variables was not as effective as the larger preassessment variable sets in correctly classifying unsatisfactorily versus satisfactorily performing student groups, the discriminant results were encouraging for those CMI environments which do not accommodate preassessment testing. These validity results and conclusions are, of course, tentative until substantiated in cross-validation studies.

4.0 DISCUSSION AND CONCLUSIONS

4.1 Discussion of Findings

The goals of this project were to (a) determine the characteristic problems which students encounter in a computer-managed instructional system and those strategies which effectively help students cope with or adapt to these problems, (b) design, develop, implement, and evaluate a small set of self-contained instructional modules for increasing the effectiveness with which students adapt to and perform in a CMI environment, and (c) investigate procedures for individualizing the assignment of these modules so as to minimize total completion times and training costs. The skill assessment and training materials developed in response to these goals were an Orientation to CMI module, a Time Management module, four Study Skills modules (Reading Comprehension, Memorization, Test Taking, Concentration Management), and a Study Skills Questionnaire. In addition, an Instructor Orientation and Training package was developed in which a workshop format was used to train instructors in diagnostic and tutorial skills necessary for effective student use of the study skills materials. The following sections summarize the results of the operational and summative evaluations of these skill training materials, followed by a discussion of evaluation conclusions and recommendations for future research.

4.1.1 Student Skill Training Modules. As will be recalled, the Orientation module was subjected to an extensive formative evaluation with both students and instructors in the AIS environment, and was administered to a number of students in the PME course in an Orientation/No Orientation design operational tryout. Due to small student flow during this later evaluation period, no reliable differences were detected between attitudes toward CMI or block performance for those students who received and those who did not receive the Orientation module. The average time which students spent to complete the module was, however, only 42 minutes, suggesting that the time for such an orientation is not excessive and that subsequent evaluations of the module could be expected to reveal student performance or attitude benefits which are well worth this minor investment of student time.

Following formative evaluation and revision, the effectiveness of the Time Management module was assessed in two phases. The question of interest in Phase I was whether the combination of Time Management skill training and progress targeting and feedback (Student Progress Management Component) would result in significant reductions in block and course completion times.

There is little doubt that the combination of the Time Management module and Student Progress Management Component did result in substantive time savings--an 11.2 percent reduction in the time required for students to complete the six blocks of the IM course. This 11.2 percent savings represented 2.87 fewer days spent in a learning center by the

average student. Since the normal IM course entry rate is 60 students per week for 50 training weeks per year, the total yearly savings amounts to 8,600 student training days.

The Phase I block score, block failure rate, and student attitude results demonstrated less positive, but not totally unanticipated, effects. That is, block test scores were lower, failure rates were higher, and attitudes tended to be less positive for students in the progress management condition as compared to the no-management condition. These results are consistent with the findings of Johnson et al. (1972) with respect to attitudes and with those of Colton (1974) for criterion test scores, both of whom investigated the effects of giving students predicted completion time information. The results also agree with Fernald (1975) and Reiser and Sullivan (1977), who investigated the effects of instructor-paced versus student-paced conditions. Increased emphasis on completing the course quickly appears to have caused students to accept a greater risk of failure on end-of-block criterion tests, and the lower attitude scores may reflect feelings of conflict about this trade-off of shorter times for lower scores.

A study by McMillan (1977) suggests another explanation for the less positive attitudes of students in the management condition. The interactive effects of students' degree of effort and the nature of written instructor feedback on student attitudes toward the subject were investigated in four university classes. High and low effort assignments were studied within conditions of high praise or no praise. McMillan found that students in the high effort/high praise condition formed significantly more positive attitudes than did students in the other three groups. The poorest attitudes were found for students in the high effort/no-praise condition. These findings imply that the progress management condition (a high effort condition relative to no-management) students may not have received enough instructor praise or encouragement for their efforts in maintaining their target rates to provide the environment required for positive attitude formation.

The question of interest on Phase II of the evaluation was whether the Time Management module per se, in the presence of the Student Progress Management Component, contributed significantly to training time reductions. The data from this second phase indicate a substantial time savings attributable to the Time Management module--14.77 percent for students who completed all six blocks of the IM course. A word of caution is in order, however, in interpreting these time savings. The samples in the later blocks were small and were comprised of the faster students. Even though no interactions were found between the effect of the module and predicted course completion time, the data from the later blocks may not be representative. Disregarding the first block, which is confounded by the presence of the module itself, the comparisons made in the second and third blocks, both based on reasonably large n's, probably provide the most reliable estimate of time savings attributable to the module--on the order of 9 percent.

The finding that the Time Management module led to improved performance relative to a no-module group is congruent with several studies reviewed in Section 1.2.2 of this report. Croft et al. (1976) found that PSI students in a variety of monitoring conditions took fewer sessions to complete the course than did students who merely paced themselves. Similar studies by Yates and Zimbardo (1977) and Myers (1978) found performance improvements for student groups who were taught self-monitoring techniques in a self-paced environment and were required to use these techniques throughout the course, as compared to no-monitoring student groups. Thus, these studies suggest that procedures which require students to observe, record, or graph their progress are related to improved performance in self-paced learning environments.

It is of interest to assess the time savings which can be attributed to the basic Progress Management Component, to the module, and to a third factor--the continued presence of Progress Management over time. Table 29 summarizes several comparisons based on cumulative times to complete Blocks 2 and 3 by Phase I and II evaluation and control group students.

As Table 29 indicates, introduction of the combination of the Management Component and Time Management module resulted in a 12.2 percent reduction in these blocks as measured during the Phase I evaluation. There is no available measure of the immediate effect of the Management Component by itself. The module, in the presence of the Management Component, contributed a 9.1 percent time reduction as measured during Phase II. Approximately 4 months elapsed between the end of Phase I and the beginning of Phase II, and comparison of Phase I and II evaluation groups indicates that the combined effect of Management Component plus module resulted in an additional 4.27 hour reduction (7.1 percent) in these blocks during this period. Thus, the total effect of the full Management Component (including the module), after a period of time, was an 18.5 percent reduction in completion times for these two blocks. The final available comparison implies that the Management Component, by itself, would have resulted in a 10.3 percent savings, given time to have its full effect. This may be an overestimate, however, since both the Management Component and module were in effect during the intervening period.

Two major implications can be drawn from these results. First, both parts of the total Progress Management Component contribute to improvements in student efficiency which are roughly equivalent (i.e., 9.1 percent for the Module, 10.3 percent for the Progress Management Component). Second, the effects of the total Progress Management Component continued to increase over time.

The phenomenon of improving performance over time could be attributed to several factors. First, initial negative reactions by students and instructors to Progress Management may have diminished as its effectiveness for improving trainee efficiency was demonstrated. Some support for this hypothesis can be found in the more positive Phase

TABLE 29

TIME SAVINGS IN BLOCKS 2 AND 3
ATTRIBUTABLE TO VARIOUS TREATMENTS

Treatment	Comparison Groups	Time Difference in Hours	Percentage Time Savings
Management Component plus Module	Phase I Control - Phase I Evaluation	8.38	12.2
Management Component Only	Not Available	-	-
Module Only	Phase II Control - Phase II Evaluation	5.61	9.1
Time: Given Management Component plus Module	Phase I Evaluation - Phase II Evaluation	4.27	7.1
Time plus Management Component plus Module	Phase I Control - Phase II Evaluation	12.65	18.5
Time plus Management Component	Phase I Control - Phase II Control	7.04	10.3
Time plus Module	Not Available	-	-

II student attitude data as compared with the Phase I attitude data. Second, the additional 4 months of Management Component operation may have resulted in greater expertise on the part of the instructors in the use of the Progress Management Component.

Score and block failure rate data also support the contention that initial benefits increased over time. Phase II evaluation group students were generally found to score as well and experience the same number of block failures as students without the module. Further, this level of achievement was approximately that found for students prior to implementation of Progress Management. These findings suggest that the poor test performance effects observed when Progress Management was first implemented were only temporary.

That perceptions of Progress Management improved as experience with it increased is substantiated to an extent by the Phase II student attitude data. Attitude items which were most negative in Phase I tended to become more positive in Phase II, particularly those items dealing

with instructor help and encouragement. These findings agree with those of McMillan (1977) in that more positive attitudes would be expected in this high effort/high (or moderate) praise condition.

A final point concerns the time required to complete the Time Management module relative to the savings attributable to this training. In Phase II, evaluation group students had recovered the time spent on the module by the end of the first block. This result is quite consistent with Anderson's (1976) conclusions that early skill training "costs" are amortized quickly when students begin using these skills to improve their performance.

In the Study Skills training area, the findings of relevance are those found during the operational tryout of the four modules in the IM, MF, and WM courses. Although the data from this evaluation are limited with respect to number of samples, the findings of dramatic student improvement in block times and scores following study skills remediation are so consistent that it appears fairly clear that this training met the goal of increasing student efficiency and effectiveness in a CMI training environment. There was also a suggestion that providing students with study skills training improved their perceptions of their study skills, particularly if training was given in more than one study skills area. These findings are consistent with the results of a number of studies reviewed in Section 1.2.3 of this report (e.g., Groveman et. al, 1977; McReynolds & Church, 1973).

Two major implications of the study skills training results are that this relatively short training (a) continues to show its effect in improved student performance throughout the course, and (b) tends to have its most dramatic effect on the performance of students who were assigned all four of the Study Skills modules. The first of these phenomena would be expected on the basis of the strategies used to modify student study behaviors, i.e., active information processing strategies and cognitive self-control strategies. Since emphasis is placed on active and meaningful information processing, the continuing practice itself, and its immediate resultant reinforcement, would tend to maintain and strengthen the desired behaviors over time. Similarly, it would be expected that the cognitive self-control strategies, such as the positive self-talk scenarios used in the Concentration Management and Test Taking modules, would become habitual with practice.

That students assigned all four Study Skills modules tended to improve their performance to a greater extent than students receiving only one module (particularly if the one module was Reading Comprehension) may well have been due to the sheer mass of the study skills training, but it could also be attributable to inappropriate instructor matches of learning materials with student needs or the characteristics of the particular students selected for study skills remediation. It may be that the students selected had other aptitude or motivational characteristics that differentially moderated the effects of the study skills

training. This suggests that an individualized assignment procedure which uses student characteristic data in assisting instructors' diagnoses would further improve the effectiveness of study skills training.

4.1.2 Study Skills Questionnaire. The results relevant to the use of the Study Skills Questionnaire as a diagnostic tool for helping to identify those students in need of study skills remediation were quite promising. Not only were the questionnaire and its subscales found to demonstrate good reliability and construct validity, but the results of the predictive validity analyses supported the power of this measure to discriminate those students who would perform satisfactorily versus poorly in a CMI environment such as the AIS. The Quesionnnaire reliably discriminated between the groups for block times and scores, as well as lesson times and scores, suggesting the sensitivity of the questionnaire to different CMI criterion variables. A finding of importance was that the Questionnaire's ability to predict performance generally did not decrease from early to late blocks of both the IM and WM courses.

A recent study by Centra (1977) supports the relationship found between student study skills ratings and subsequent course performance. Centra investigated whether students' ratings of their skills in seven different undergraduate courses (chemistry, biology, introductory psychology, three math courses, physics) would be related to end-of-course exam performance. Ratings of more global abilities were most highly related to student performance, whereas more specific ratings of the content, difficulty, or procedures of the courses were not. This suggests that student ratings of their study skills are most predictive when they are asked for general or global opinions of their abilities in certain general skills required for the course--a characteristic of the items of the Study Skills Questionnaire.

The results of a study by Bornstein, Hamilton, Miller, Quevillon, and Spitzform (1977) further suggest that not only are self-rating scales more likely to be related to student performance than ability measures, but that there are a number of techniques that can be used to improve the reliability and validity of self-report scales. For example, Bornstein et al. report that taking the time to tell students that they are independent thinkers, that they are believed to have high integrity and to be able to evaluate themselves honestly, and that inaccurate reporting of data would result in loss of time, money, and energy has the payoff of increasing the fidelity of self-reports. Thus, these findings suggest that the reliability and validity of the Study Skills Questionnaire could be further enhanced by similar procedures.

Although the preassessment variable sets available in the AIS environment were somewhat more effective than the Questionnaire variables in discriminating those students who perform satisfactorily versus poorly with respect to completion times and criterion test scores, there are a number of issues related to the operational application of the Study

Skills Questionnaire in a CMI environment that should be addressed. First, for those CMI environments which do not support preassessment testing or the use of precourse student data in performance predictions, it may be more efficient to simply implement the Questionnaire for predictive and diagnostic purposes, rather than designing and implementing some type of precourse assessment procedure. The second issue is related to the intended use of the Study Skills Questionnaire in a CMI environment as a prescriptive and/or diagnostic tool. On the basis of the present findings, it would appear that the Questionnaire could at least be used to supplement the prediction of student performance, in that it serves a highly useful function in the diagnosis of particular weaknesses in student study skills, and thus facilitates the instructor's remediation decisions.

A final issue concerns the use of the Questionnaire in the diagnosis of particular study skill weaknesses, and whether it might be more efficient to simply administer all four Study Skills Modules to students predicted to have trouble satisfactorily performing in a CMI course, rather than using the Questionnaire to select particular Study Skills Modules for particular student needs. Related to this issue is the question of how important it may be to give the instructors a more expanded role in using the Questionnaire data to make refined diagnostic and remedial decisions. All of these issues, then, are important considerations in arriving at recommendations regarding how the Study Skills Questionnaire should be used in various CMI environments.

4.1.3 Instructor Orientation and Training. As was discussed previously in this report, in the process of designing and implementing the student skills training modules, it became apparent that additional mechanisms would be necessary to effectively transition these modules into the CMI training environment. That is, instructor understanding and appreciation of the goals and objectives of this skills training, as well as the implementation procedures and strategies involved, were considered to be critical to the potential success of such skills training. For this reason, it was decided that an instructor orientation and training package should be developed to acquaint instructors with project goals and with basic diagnostic and tutorial skills required for the individualized assignment of the student study skills materials. This instructor package and its associated procedures was developed in place of the originally planned computer-based individualization procedures.

Data for evaluation of the Instructor Orientation and Training package were provided both by the instructor critiques of the workshop training content and procedures, and by instructors' subsequent use of their new skills in assigning students to particular study skills materials. With respect to the critique data, instructor comments from the formative and operational tryouts of the workshops were generally favorable, with a majority of the 27 participating instructors indicating that they liked both the content and format of the workshops. These findings, then, support those of previous researchers who have reported

on the success of a workshop format for instructor training (e.g., Cadenhead, 1976; Gall et al., 1978; Rash & Grimm, 1976).

An index of the success of the instructor orientation and training procedures is also provided by examination of the number of students per course who were subsequently assigned some type of study skills remediation, and their performance following this remediation. Of the 27 instructors who participated in the formative or operational tryouts of the workshops, 18 had subsequent changes in their work assignments (e.g., to curriculum writing), leaving only nine instructors (three from IM, one MF, five from from PME) who were in a position to assign the Study Skills modules during the 10-week evaluation period. Referring to Table 9 in Section 3.3.1, the three IM instructors assigned materials to seven students, for an average of about 2.3 assignments per instructor. The one MF instructor assigned materials to two students. The five WM instructors assigned materials to 12 students, for an average of about 2.4 assignments per instructor. As was pointed out in Section 3.3.1, however, these numbers are misleading in that discussions with instructors and data clerks in these courses indicated that substantially more materials were assigned to students but were not recorded in the AIS data base. Thus, the Instructor Orientation and Training was at least moderately successful in promoting the remediation of student study skills problems--a finding further substantiated by the consistent improvements in student block times and scores following this remediation.

Another indication that the Instructor Training/Study Skills package, as a whole, was successful is reflected in the ancedotal data obtained from informal conversations with individual instructors. With few exceptions, the instructors who participated in the program indicated that although they were initially skeptical, their experience with the materials convinced them that students assigned the materials generally show dramatic improvement in course performance. Many of them, moreover, felt that the Study Skills Questionnaire and four modules should be assigned to all students at the beginning of their course. Such a decision must be made by the management of each course, but it is encouraging to note that the instructors who used the study skills materials gained confidence in their ability to teach students new, more efficient and effective behaviors. These anecdotal data support the contention that an Instructor Orientation and Training package can positively affect instructor perceptions and attitudes about their CMI roles.

4.2 Evaluation Conclusions

The conclusions from this project are discussed in the following sections, with respect to the student skills training modules, the Study Skills Questionnaire, and instructor orientation and training, respectively.

4.2.1 Student Skills Training Modules. On the basis of the results of the formative and summative evaluation activities completed on the

Orientation module, Time Management module, and four Study Skills modules, the following general conclusions can be drawn:

1. Providing students with an orientation to the novel aspects of a CMI environment is both feasible and efficient. The effectiveness of such an orientation remains to be demonstrated with respect to improving student training efficiency and effectiveness, or improving their attitudes toward the new learning processes and instructional environment.

2. Providing students with rudimentary time management skills and some method for maintaining these skills throughout the course is highly feasible and cost-effective, particularly when this skills training is combined with a system for predicting completion times and providing rate of progress feedback to students and instructors. The effectiveness of time management skills training would be expected to be enhanced in environments in which instructors are appropriately trained in and accepting of the training concepts.

3. Providing students with specific study skills remediation which capitalizes on their active information processing strategies and/or provides them with methods for controlling dysfunctional behavior is highly feasible and promises to be cost-effective in terms of improved training effectiveness and efficiency. Further enhancements to the effectiveness of such study skills training would be expected from efforts to refine the identification of students in need of such training, including expanded instructor training programs and computer-based individualization decision models.

4. While the Time Management module was the only product of this project which could be evaluated over an extended period of time, the results strongly suggest that benefits of specific skills training can be expected to increase over time. To a large extent this is probably due to increased instructor expertise with respect to the skills training materials and procedures, but a second significant component may be the simple acceptance of the materials and procedures as a standard part of the training environment.

4.2.2 Study Skills Questionnaire. The following conclusions can be drawn from the Study Skills Questionnaire summative evaluation results:

1. A self-report rating of student study skills in areas identified as important in a CMI environment (reading comprehension, memorization, test taking, concentration management) is both a reliable and valid method of assessing areas of student strengths and weaknesses. The fidelity of this measure might be further enhanced by incorporating instructions which stress the importance of honest answers.

2. The Study Skills Questionnaire in its present form has suffic-

ient predictive validity to be of use to CMI instructors in the prediction and/or diagnosis of those students expected to have difficulty completing their course efficiently and effectively. Additional analyses would be required to provide instructors with the specific cut-off scores on each of the questionnaire's subscales that would indicate student need for a particular Study Skills module.

3. The Study Skills Questionnaire could be used as a reliable diagnostic and/or prescriptive tool in lieu of a battery of precourse assessment procedures or as a supplement to these procedures.

4.2.3 <u>Instructor Orientation and Training</u>. Conclusions which can be drawn in this area are based both on the results of the formative and summative evaluations of the instructor workshops, and on the results of the Study Skills modules evaluation.

1. A definite requirement exists in CMI environments to provide instructors with skills training in those roles required to effectively and efficiently perform their function as facilitator of the learning process. Such training can be feasibly and effectively accomplished in a workshop format which includes participative discussions and practice of new skills.

2. Instructor training in the diagnostic and tutorial skills required to effectively remedy student study skills problems is feasible and can be accomplished efficiently. Further enhancements to such training might include continued instructor follow-up on the use of their new skills and broadening the training to other areas required in a CMI environment (e.g., handling student motivational problems, assessing additional learning weaknesses).

3. Instructor training in specific CMI roles and the skills required to effectively perform these roles can have a positive impact on instructor attitudes toward and role perceptions in a CMI environment.

4.3 Requirements for Future Research

This project has demonstrated the positive benefit of student skills training on reducing the costs of military technical training. There are, however, a number of questions that remain unanswered. This section lists these questions as areas recommended for future research.

1. The need exists to investigate the effectiveness of the Orientation module in the AIS and/or other CMI technical training environments with respect to its impact on students' performance and attitudes.

2. Research aimed at individualizing the assignment and/or reassignment of time management skill training is desirable, in that it has the potential of further enhancing student training efficiency and effectiveness.

3. As with student training in time management skills, there is a need to investigate methods for individualizing the assignment of study skills training in order to obtain maximum benefit from this type of training.

4. Additional research which isolates the cut-off scores on the Study Skills Questionnaire which are most reliably related to student performance (times, scores) and their need for particular study skills remediation in CMI technical training courses, is needed to further the utility of this measure.

5. A critical need exists to explore the types of roles required of instructors in a CMI environment, particularly as these relate to their function as facilitators of the learning process, and specific training packages need to be developed and evaluated in CMI training environments.

4.4 Recommendations For Use of Materials Produced in This Project

1. The Orientation/Time Management Modules should be implemented near the beginning of CMI technical training courses to improve student efficiency and attitudes.

2. The Study Skills Questionnaire should be made part of the pre-assessment battery for each course or placed in the first course block so that it can be used to help identify students with specific study skills problems or those who will have difficulty successfully completing the course.

3. The four Study Skills Modules should at least be implemented in all CMI courses to be used by students identified as having study skills problems. Consideration should also be given to using these skill modules in non-CMI technical training courses.

4. An Instructor Orientation and Training Workshop in those skills required to effectively use the Study Skills Questionnaire and Modules should become an on-going in-service training program in each course.

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APPENDIX A:

Glossary of Terms

GLOSSARY OF TERMS

ADAPTIVE MODEL - Consists of a set of computer programs that generate individual instructional assignments, predict and assign individual block and course completion time targets (student progress management), allocates training resources, and is the vehicle for accomplishing continual test and courseware evaluation and refinement.

ADVANCED INSTRUCTIONAL SYSTEM (AIS) - A prototype, comprehensive computer-managed and computer-assisted instructional system to provide the following automated capabilities in support of large scale training: individual instructional assignments, student progress management, resource allocation and scheduling, information storage, and report generation and evaluation and research.

ALTERNATIVE MODULES - Modules utilizing different instructional approaches from previously existing modules to meet the specific needs of particular types of students and/or certain course requirements. (See Instructional Module).

AUDIO-VISUAL (A/V) - A method of displaying information in which both the audio segment and visual segment are electro-mechanically and optically reproduced for the information of the student, e.g., photographic slides used in conjunction with an audio tape player.

BLOCK - A course component comprised of lessons and modules that cover a specific subject/content area and normally ends with a comprehensive test.

BLOCK COMPLETION/ELAPSED TIMES - The period of time from inception of a block's first lesson or lesson group through completion of the block test.

COMPUTER HARDWARE - The hardware components that comprise the computer system and includes the central processor, various types of memory units, printout unit and control, display and distribution units.

COMPUTER-MANAGED INSTRUCTION (CMI) - Use of the computer to manage students through the instructional process. The computer's role is that of a diagnostician and manager of instructional events. Through the Adaptive Model, it generates Individual Instructional Assignments (IIAs), predicts and assigns individual block and course completion times, allocates training resources and evaluates tests and courseware. The utilization ratio is 100 students per management terminal.

COMPUTER SOFTWARE - A logical grouping of programmed computer codes that gives commands to a computer to perform a particular function. A unique AIS software component is the Computer Assisted/Managed Instructional Language (CAMIL) that facilitates both CAI and CMI.

CONVENTIONAL TRAINING - Classroom and/or laboratory training conducted in a previously established and accepted manner, i.e., usually a classroom lecturer and/or laboratory instructor-student group relationship in a lock-step mode of progress.

COURSE - A block or a series of blocks of instruction designed to satisfy Specialty Training Standards for a particular Air Force Specialty Code and skill level. Formal, resident training conducted at an Air Training Command installation.

COURSE COMPLETION PREDICTIONS - A computer-generated estimate of a student's time required to complete the course based upon Preassessment Testing. Predictions may be made for completion of modules, lessons, or blocks as well as for the entire course.

COURSE COMPLETION TARGET - A course completion prediction adjusted for course policy regarding the desired minimum, maximum and average course completion times.

COURSE COMPLETION TIMES - Measured classroom time from course entry to graduation.

COURSE DATA BASE - A collection of computerized files containing the parameters and flags which control the operation of the Adaptive Model for a specific course.

COURSEWARE - Generic term for all AIS instructional material.

CRITERION-REFERENCED TESTING - A testing methodology in which test items are written to assess student performance on defined behavioral objectives with respect to a specified standard of mastery (e.g., 70 percent correct).

CRITERION VARIABLES - Measures of student performance, times, and score on lesson and block tests.

DAILY ROSTER - A computer generated listing of students assigned to a specific learning center, their assigned carrel numbers, current block of instruction, and rate of progress relative to their target course completion rate.

EQUIVALENCE OF GROUPS - Analysis of groups of students included in the IST to assure that they do not vary significantly in ability or other psychological variables (preassessment) and, as a result, do not bias the results of the time savings analyses.

FIRST ATTEMPT BLOCK FAILURES - A computer produced list of the number of students who fail to meet criterion on their first attempt to pass an end-of-block test.

GLOSSARY OF TERMS (Continued)

FORMATIVE EVALUATION - That type of evaluation research whose purpose is to detect weaknesses in instructional materials or procedures and provide a basis for correcting such weaknesses.

INDIVIDUALIZATION - See Individualized Instructional Assignment.

INDIVIDUALIZED INSTRUCTIONAL ASSIGNMENT - The AIS/CMI capability to assign individual students to alternative modules of instruction for a lesson in order to achieve optimal performance from each student.

INSTRUCTOR WORKSHOPS - A training format used during the formative and summative evaluations. Emphasis of these workshops was on the training of instructors in study skill techniques and diagnostic, counseling and remediation skills, in participative discussion and practice sessions.

INSTRUCTIONAL MATERIALS - Printed, audio, or visual information used in instruction. Includes programmed texts, picture books, workbooks, audio visuals, checklists, technical orders and tests.

INSTRUCTIONAL MODULE - A specific package of instructional materials and related training resources for presentation of a specific AIS lesson. A lesson may have more than one instructional module. All modules for a lesson teach the same objectives but differ in the method of presentation and/or strategies used.

INTEGRATED SYSTEM TEST - An evaluation of the Advanced Instructional System designed to provide quantitative answers regarding the training time reductions resulting from certain Computer Managed Instruction (CMI) functions of the AIS.

INTERACTIVE (A) TERMINAL - Consists of a plasma display and keyboard and is used by instructors and course authors to interact with the AIS central computer and data files and by students for on-line, adaptive testing and CAI.

LEARNING CENTERS - A learning environment to which students are assigned for attendance-taking purposes and in which most coursework is conducted. Consists of carrels, media and job related equipment and/or simulators designed to support individualized instruction.

LESSON - A component of a block of instruction. Contains instructional information to enable achievement of a learning objective or series of objectives. A lesson is learned through the use of one or more specific instructional modules.

MANAGEMENT (B) TERMINAL - Consists of a forms reader, printer and mini-computer and is used to read and score test forms, transmit data to and receive information from the AIS central computer, and print student prescriptions and management reports.

MODULE - The smallest testable unit of instruction within a block of instruction. A set of instructional materials which applies a specific instructional approach for teaching a lesson. (See Instructional Module).

MULTI-TRACK - A concept used to describe individualization strategies used in alternative modules for a lesson. For example, alternative modules for a lesson may be produced to accommodate student needs by using mediums and different levels of redundancy or difficulty. Thus, the presentation strategies will differ for alternative modules in the multi-tracking category; presentation media may or may not differ.

OPERATIONAL TRYOUT - Defined for the project, as a second phase of the formative evaluation accomplished by a large-scale evaluation. During this phase, the primary consideration was the effect of the treatment on the subjects subsequent behavior.

PREDICTOR VARIABLES - Measures of student abilities, aptitudes, interests, personality, or past performance which are expected to be related to criterion variables of interest (e.g., student times or scores).

PREASSESSMENT DATA - The results of a test battery given to students before they begin a course. The battery is designed to measure student abilities, attitudes, interests and backgrounds. Preassessment data, in conjunction with Within-Course Testing is used for Individualized Instructional Assignment and Student Progress Management.

PRESCRIPTION - A computer generated student status report indicating the student's performance on his/her last assignment, his/her next assignment, and related training resources required, if any.

RANDOM ASSIGNMENT - The option to specify the percentage of students who should be assigned randomly to the alternative module for a lesson. Provides experimental control groups for AIS related research and/or for development of regression equations.

RESOURCE ALLOCATION - A CMI function of the Adaptive Model for managing all training resources declared in the Course Data Base as computer-managed. The AIS capability to balance student flow through a module, lesson, block or course to avoid queueing as a result of resource unavailability and to maximize use of critical resources.

SELF-PACING - A generic description of programs where learning and progress occur at each student's self-established pace. Generally, students whose rate of progress exceeds predetermined limits are counseled.

SKILL TRAINING - That instructional training aimed at the remediation of or compensation for particular student weaknesses in academically related areas (e.g., self-management skills, study skills).

SMALL-GROUP TRYOUTS - Defined in this project as the first phase of the formative evaluation. During this phase, the primary concern was to what extent the treatment was performing as designed.

SOFTWARE - See Computer Software

STATE OF THE ART - Current level, state, or condition of technology in disciplines related to computer-based education and training.

STRATEGIES - Specific instructional techniques applied within a module, lesson, block, or other sequence of instruction and designed to meet individual needs and characteristics of various types of students considering the particular learning objective.

STUDENT DATA PROFILE (SDP) - A computerized file that maintains comprehensive records for each student enrolled in an AIS course. Each student record contains bibliographic, preassessment and within-course performance data.

STUDENT PROGRESS MANAGEMENT COMPONENT (SPMC) - The AIS capability to predict and assign individual block and course completion time targets based on each student's individual aptitudes, abilities, and performance and to provide students and instructors with daily feedback on each student's progress toward the target completion times.

SUMMATIVE EVALUATION - That type of evaluation research whose purpose is to assess the overall operational effectiveness of a program via a large scale tryout. For the purposes of this project, summative evaluation was considered to be a second large-scale tryout in which data on approximately 50 students per treatment were collected.

TARGETED COURSE COMPLETION RATE - A computer generated rate of progress through a course for each student which he/she must maintain to meet the course completion target.

TEST-WISENESS - The ability to combine subject knowledge with clues in the test to get a score which reflects how much a person knows about a specific subject.

GLOSSARY OF TERMS (Continued)

WITHIN COURSE DATA - Data describing student performance (lesson and block times and scores) within a course as compared to preassessment and/or bibliographic data.

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